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

# 2013

**Ministry of Environmental Protection**

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# Content



# Summary

The Three Gorges Project was in safe operation in 2012, creating substantial overall benefits. The project carried out four operations to prevent floods with maximum discharge above 50,000 $m^3/s$, withstood the test of maximum discharge at 71,200 $m^3/s$, and buffered the floods so the downstream waters did not rise above safety level, protecting the midstream and downstream of the Yangtze River from floods. The objective to reach the trial impoundment level of EL.175m was achieved once again at the end of the flood season. The Three Gorges ship lock was maneuvered for over 9,000 gate•times throughout the year, and has been in safe and effective operation for nine straight years. The Three Gorge Power Station generated up to 98.1 billion kWh of electricity all over the year, far beyond the annual target.

The registered total population of the Three Gorges Project area amounted to 16,776,600, up 0.3% from a year earlier. The local public health was in good conditions and there was no report on epidemic outbreak. The local GDP totaled 511.106 billion yuan, up 13.9% from a year earlier when calculated at the comparable price. The value-added of the primary, secondary, and tertiary industry in the area registered 54.781 billion yuan, 294.208 billion yuan, and 162.116 billion yuan respectively, up 12.6%, 11.6%, and 22.7% against the 2011 levels.

The mean annual temperature (MAT) of the project area registered 17.6℃, approximate to historical average; the mean annual precipitation (MAP) 944.6 mm, on the low side compared with historical average; the mean annual relative humidity (MARH) 74%, far below historical average; the mean annual evaporation 1,135.6 mm, on the low side against historical average; the mean annual wind speed (MAWS) 1.1 m/s, also on the low side against historical average; and the mean number of days with fog 11, abnormally lower than historical average.

The Three Gorges project area was covered with 2,685,400 ha. of forests, with the forest coverage at 46.57%. The living wood growing stock amounted to 136,204,400 $m^3$, including 131,983,200 $m^3$ of forest growing stock which accounted for 96.90%. The farmland area registered 410,812 ha., and the sown area of farm crops totaled 702,678 ha.. The multiple-cropping index was 256%, and the dominated crops remained grain crops.

The total catches of natural fishes amounted to 55,500 t in the reservoir area, downstream of the dam, Dongting Lake, Poyang Lake, and the Yangtze River estuary, up 19.3% from a year earlier. The larvae flow of the four major Chinese carps *(Mylopharyngodon piceus, Ctenopharyngodon idellus, Hypophthalmich-thyus molitrix, Aristichthys nobilis)* were around 397 million in the monitoring sections in the downstream of the dam, some increment compared with last year.

Up to 573 earthquakes at or above magnitude 0.0 were recorded from the head region to the central region of the project area, some rise from last year. The magnitude of the earthquakes, mainly light, minor, and micro quakes, scaled up from last year. The earthquakes were mainly recorded along the banks of Yangtze River reaches between Wushan County of Chongqing Municipality and Badong County-Zigui County of Hubei Province. The early warning system for geological hazards helped identify 52 deformed landforms prone to collapses and landslides as well as actual collapses and landslides.

The industrial pollution sources in the Three Gorges project area discharged up to 173 million t of wastewater which contained 33,100 t of chemical oxygen demand (COD) and 2,000 t of ammonia nitrogen. The municipal wastewater amounted to 731 million t which contained 142,400 t of COD and 24,800 t of ammonia nitrogen. The pesticides applied in the project area totaled 701.3 t, almost the same as last year. The fertilizers applied amounted to 157,000 t, up 1.9% from a year earlier. The oil-contaminated water discharged by the shipping vessels totaled 510,200 t, and 95% got treated; 86% of the effluent of treated water attained discharge standards. The municipal sewage discharged by shipping vessels was around 3.971 million t.

The mainstream of the Yangtze River recorded good water quality in the project area throughout the year. The tributary Jialing River observed excellent water quality, whereas tributary Wujiang River failed to attain water quality standards for total phosphorus (TP). The percentage of eutrophic sections of tributary rivers in the project area ranged between 7.8% and 37.7% during the algal bloom sensitive period from March to October, some improvement from last year. Algal blooms were observed in some of the tributary rivers.

# Chapter 1
# Operation of the Three Gorges Project

The Three Gorges Project was in safe and steady operation this year and created substantial benefits. The project carried out four operations to prevent floods with maximum discharge over 50,000 $m^3/s$, withstood the test of maximum discharge at 71,200 $m^3/s$, and buffered the floods so the downstream waters did not rise above safety level, protecting the midstream and downstream of the Yangtze River from floods. The objective to reach the trial impoundment level of EL.175m was achieved once again at the end of the flood season. The Three Gorges Power Station generated up to 98.1 billion kWh of electricity all over the year, far beyond the annual target. The Three Gorges ship lock was maneuvered for over 9,000 gate•times throughout the year, and has been in safe and effective operation for nine straight years. The tower barrels of the ship lift project were roof-sealed smoothly, and the installation of ship chamber structures and equipment was in full swing. The civil engineering and electromechanical engineering of the underground power plant project were fully completed, and all of the six generating units commenced commercial operations. The Three Gorges Dam was rated as A-level safety unit during its initial registration with safety authorities. The fire control project of the Three Gorges Project passed the acceptance check. The Project was appraised as one of the first National Ecological Progress Project on Water and Soil Conservation.

### ● Overall regulation

The water level of the Three Gorges Reservoir started to decline at the end of last December and registered 146.35 m at 8:00 on June 10, 2012. The task to bring down the water level before flood season was accomplished. The Three Gorges Project was in normal operation during the water subsiding period, and discharged a total of 21.5 billion $m^3$ of water resources to downstream watersheds. Two ecological regulation tests were carried out between May 25 and 31, and June 24 and 27, and the monitoring data proved the ecological regulation plays a positive role in facilitating propagation of the four major Chinese carps.

The Reservoir withstood four floods during the flood season of the year, each with maximum discharge above 50,000 $m^3/s$; the maximum discharge was 71,200 $m^3/s$ observed at 20:00 on July 24, a record high since the Reservoir was built. Twenty-six flood regulation orders were carried out in the Reservoir during the flood season, cutting down the peak discharge by as much as 28,200 $m^3/s$ (40%). The impounded water level of the Reservoir reached as high as 163.11 m, and a total of 22.84 billion $m^3$ floodwater was impounded and blocked, protecting the middle and lower reaches of the Yangtze River from floods.

The Three Gorges Reservoir officially commenced impoundment as of September 10, and by October 30, succeeded in reaching the trial impoundment level of EL.175m for the third consecutive year.

### ● Operation of power stations

The Three Gorges Power Station generated 98.107 billion kWh of electricity throughout the year. Three Gorges-Gezhouba Cascade Hydropower Complex generated a total of 114.75 billion kWh of electricity this year, 10.75 billion kWh more than the annual plan of 104 billion kWh. The last generating unit of the underground station of the Three Gorges Power Station was delivered for service on July 4, and the entire Station ran for 711 hours steadily at the designed rated capacity of 22.5 million kW. The Station also ran for 1,437.70 hours at the capacity of 20 million kW. It had been in safe operation for 2,328 consecutive days by December 31.

### ● Navigation management

The Three Gorges ship lock operated for 9,713 gate•times this year and handled 44,000 ship•times of shipping vessels, 244,000 person•times of passengers, and 86.11 million t of freight. Also, a total of 8.78 million t of ship cargoes were transferred through ground transport means between the upstream and downstream of the Three Gorges Dam. The ship lock had been in safe and efficient operation for over nine years by 2012,

and up to 550 million t of freight had shipped through the ship lock. The technical indicators met the designed requirements for operation. The first annual repair of the five-stage ship lock in the south line was completed safely and nicely between March 7 and 26.

● **Project construction**

The last generating unit of the underground power station of the Three Gorges Project completed installation and commenced commercial operations as of July 4, 2012. The 500 kV step-up substation and EL.120m air-conditioner room finished renovation in October. The main complex of the underground power station was renovated in November. The concrete placement for the first and second phases of the ship lift extension project and the part embedment and equipment installation tasks for the second phase of the project were carried out. A total of 709 civil engineering and metal structure installation elements of the underground power station project and ship lift extension project went through quality evaluation. All elements were found qualified and 99.3% had excellent or good quality. The electricity generating units with combined weight of 1,530 t were installed, 36,800 $m^3$ of concrete was placed, and 4,970 t of metal structures and electromechanical parts were either embedded or installed for the above said two projects.

● **Acceptance check**

The Three Gorges Water Conservancy Project (Dam area) was appraised by Ministry of Water Resources as one of the first batches of National Ecological Progress Project on Water and Soil Conservation in Beijing on August 25. Fire Department with the Ministry of Public Security delegated the Fire Corps of Hubei Province to give acceptance check on the firefighting facilities of the Three Gorges Project between December 7 and 10.

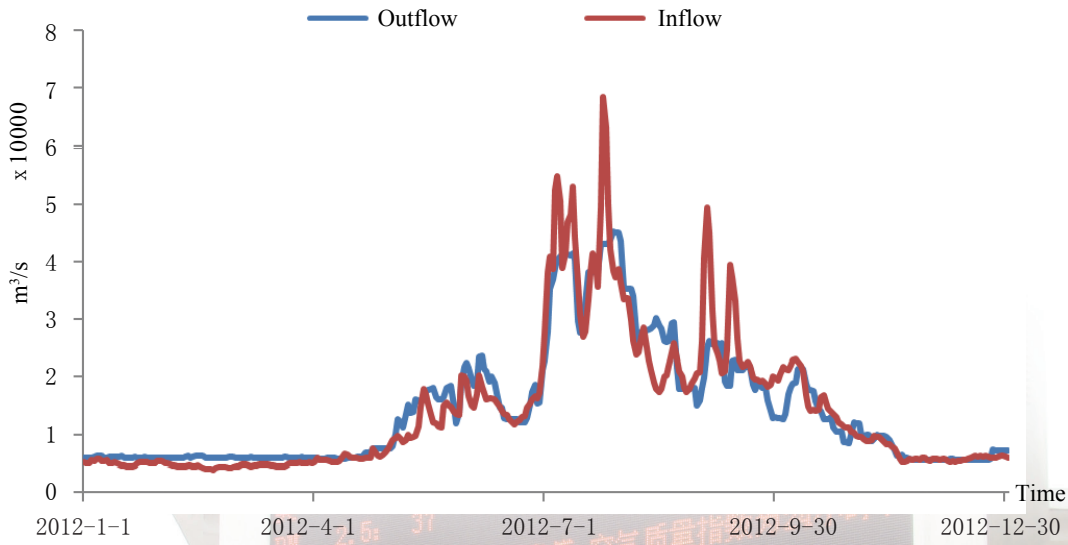



Figure 1–1 Statistics on the inflow and outflow of the Three Gorges Reservoir in 2012

# Chapter 2
# Economic and Social Development

There were 16,776,600 registered populations in the Three Gorges Project area in 2012, up 0.3% from a year earlier. Among them, there were 11,350,300 agricultural populations, down 1.1% from a year earlier, and 5,426,200 non-agricultural populations, up 3.3% from a year earlier. The non-agricultural populations accounted for 32.3% of the total population.

The local GDP of the project area totaled 511.106 billion yuan, up 13.9% from a year earlier when calculated at the comparable price. Among them, the local GDP of Hubei-based project area registered 54.679 billion yuan, up 13.5% from a year earlier, and that of Chongqing-based project area amounted to 456.427 billion yuan, up 14.0%. The value-added of the primary industry in the project area was 54.781 billion yuan, up 12.6%; secondary industry 294.208 billion yuan, up 11.6%; and tertiary industry 162.116 billion yuan, up 22.7% from the previous year. Among others, the value-added of industry amounted to 243.758 billion yuan, up 9.9%. The ratio of the value-added of the primary, secondary, and tertiary industry was 10.7:57.6:31.7. The share of the primary industry was further on the decline, whereas that of the tertiary industry grew fast.

The combined fiscal revenue of local districts and counties in the project area amounted to 55.872 billion yuan, a year-on-year increase of 17.8%. Among them, 3.385 billion yuan was the fiscal revenue of localities in Hubei-based project area, up 34.5% compared with the same period last year, and 52.487 billion yuan was revenue of localities in Chongqing-based project area,

Table 2–1 Statistics on main economic indicators in the Three Gorges Project area in 2012

| Indicator | Three Gorges Project Area | | Hubei-based Project Area | | Chongqing-based Project Area | |
|---|---|---|---|---|---|---|
| | Absolute value | Year-on-year variation | Absolute value | Year-on-year variation | Absolute value | Year-on-year variation |
| Year-end total registered population (10,000) | 1677. 65 | 0. 3% | 157. 34 | 0. 1% | 1520. 32 | 0. 3% |
| Agricultural population (10,000) | 1135. 03 | −1. 1% | 127. 00 | 0. 0% | 1008. 03 | −1. 2% |
| Non-agricultural Population (10,000) | 542. 62 | 3. 3% | 30. 34 | 0. 5% | 512. 28 | 3. 5% |
| Local GDP (100 mil. yuan) | 5111. 06 | 13. 9% | 546. 79 | 13. 5% | 4564. 27 | 14. 0% |
| #Industry (100 mil. yuan) | 2437. 58 | 9. 9% | 293. 03 | 21. 8% | 2144. 55 | 15. 9% |
| Local fiscal revenue | 558. 72 | 17. 8% | 33. 85 | 34. 5% | 524. 87 | 16. 8% |
| Local fiscal expenditure | 849. 27 | 18. 9% | 90. 01 | 17. 3% | 759. 26 | 19. 1% |
| Percapita net income of ruralresidents | 7385. 01 | 14. 9% | 6302. 00 | 15. 3% | 7508. 00 | 14. 8% |
| Per capita disposal income of urban residents (yuan) | 21276. 50 | 13. 8% | 16799. 00 | 15. 3% | 21479. 00 | 13. 4% |
| Total fixed-asset Investment (100 mil. yuan) | 4275. 76 | 24. 0% | 422. 29 | 41. 0% | 3853. 47 | 22. 4% |
| Total retail sales of consumer goods (100 mil. yuan) | 1439. 22 | 16. 4% | 140. 11 | 14. 6% | 1299. 11 | 17. 5% |

up 16.8%. The fiscal expenditure of local district/county governments totaled 84.927 billion yuan, a year-on-year increase of 18.9%. Among them, 9.001 billion yuan was spent by Hubei-based project area, up 17.3% compared with the same period last year; and 75.926 billion yuan by Chongqing area, up 19.1%.

The grain output totaled 6,150,100 t, down 0.1% from a year earlier; and the total output of meat amounted to 1,152,600 t, a year-on-year increase of 2.7%.

The per capita disposal income of the urban residents in the project area was 21,277 yuan, up 13.8% compared with the same period last year; the per capita net income of rural residents registered 7,385 yuan, a year-on-year increase of 14.9%. Among others, the per capita disposal income of the urban residents in Chongqing-based project area was 21,479 yuan, up 2,540 yuan and a year-on-year increase of 13.4%; and the per capita net income of rural residents there 7,508 yuan, up 961 yuan and a year-on-year increase of 14.8%. The per capita disposal income of urban residents in Hubei-based project area was 16,799 yuan, up 2,131 yuan and a year-on-year increase by 14.5%; and the per capita net income of rural residents in the area amounted to 6,302 yuan, up 837 yuan and a year-on-year increase by 15.3%.

The total fixed-asset investment of the project area was 427.576 billion yuan, a year-on-year increase by 24.0%. Among others, the total fixed-asset investment amounted to 42.229 billion yuan in Hubei-based project area, up 41.0% compared with the same period last year; and 385.347 billion yuan in Chongqing area, up 22.4%. The total retail sales of consumer goods were 143.922 billion yuan, a year-on-year increase by 16.4%. Among others, the total retail sales of consumer goods in Hubei-based project area registered 14.011 billion yuan, up 14.6% compared with the same period last year; and 129.911 billion yuan in Chongqing area, up 17.5%.

# Chapter 3
# Natural Ecology and Environment

## 3.1 Climate

The mean annual temperature (MAT) of the Three Gorges Project area this year was approximate to historical average, and the mean annual precipitation (MAP) was on the low side compared with historical average. The climate in the project area this year was dry and cold in the winter, humid and chilly in the spring, torrid in the summer and cool in the autumn, with precipitation above historical average in the spring, below historical average in the summer and winter, and approximate to historical average in the autumn. The mean annual evaporation (MAE) in the project area was on the low side compared with historical average; the mean annual relative humidity (MARH) was much lower; the mean annual wind speed (MAWS) was lower; and mean number of days with fog were abnormally lower than historical average. The meteorological hazards in the project area were mainly low temperature and continuous rain, rainstorm, drought, high temperature, and gale and hails.

Table 3–1 Monitoring data of the meteorological elements from representative meteorological stations in the Three Gorges Project area in 2012

| Station | MAT (℃) | MAP (mm) | MARH (%) | MAE (mm) | MAWS (m/s) | Duration of sunshine (hr.) | No. of days with fog (day) | No. of days with thunderstorm (day) |
|---|---|---|---|---|---|---|---|---|
| Chongqing | 18.8 | 1,104.4 | 72 | 1,121.7 | 1.4 | 812 | 9 | 30 |
| Changshou | 18.1 | 982.40 | 80 | 790.1 | 1.2 | 935 | 25 | 22 |
| Fuling | 18.6 | 993.7 | 75 | 1,214.6 | 0.8 | 786 | 11 | 33 |
| Fengdu | 18.8 | 1,001.2 | 76 | 1,043.1 | 1.1 | 1,116 | 13 | 34 |
| Zhongxian | 18.0 | 898.2 | 86 | 978.4 | 1.1 | 934 | 14 | 25 |
| Wanzhou | 18.6 | 1,016.1 | 74 | 1,332.6 | 1.1 | 1,073 | 1 | 30 |
| Yunyang | 18.2 | 926.5 | 77 | 1,198.6 | 1.1 | 1,078 | 0 | 43 |
| Fengjie | 18.3 | 768.8 | 67 | 1,297.8 | 1.6 | 1,234 | 3 | 25 |
| Wushan | 18.5 | 828.5 | 65 | 1,246.4 | 0.5 | 1,293 | 0 | 25 |
| Badong | 17.1 | 942.5 | 68 | 1,452.1 | 1.7 | 1,252 | 30 | 26 |
| Zigui | 16.3 | 949.3 | 79 | 742.6 | 0.8 | 1,380 | 13 | 34 |
| Bahekou | 16.8 | 924.6 | 79 | 1,081.8 | 1.2 | 1,140 | 7 | 29 |
| Yichang | 17.1 | 923.4 | 74 | 1,209.3 | 1.2 | 1,207 | 17 | 33 |

### 3.1.1 Meteorological elements

The mean annual temperature (MAT) of the project area registered 17.6℃ this year, approximate to but on the low side of historical average. Regional analysis indicated the local MAT was approximate to historical average in Chongqing, Fuling, Fengdu, and Yichang; up 0.15℃ in Changshou, 0.2℃ in Wanzhou, and 0.28℃ in Fengjie; and down 0.61℃ in Zhongxian, 0.93℃ in

Yunyang, 0.17℃ in Wushan, and 0.59℃ in Badong. Seasonal data indicated the mean seasonal temperature was lower than the historical average in the winter and autumn, higher in the summer, and approximate in the spring. Monthly data showed the mean monthly temperature was a little above the monthly historical average in April, June, July, and August, and slightly lower in the rest months. Among others, February recorded the maximum fluctuation in temperature by dropping up to 1.0℃.

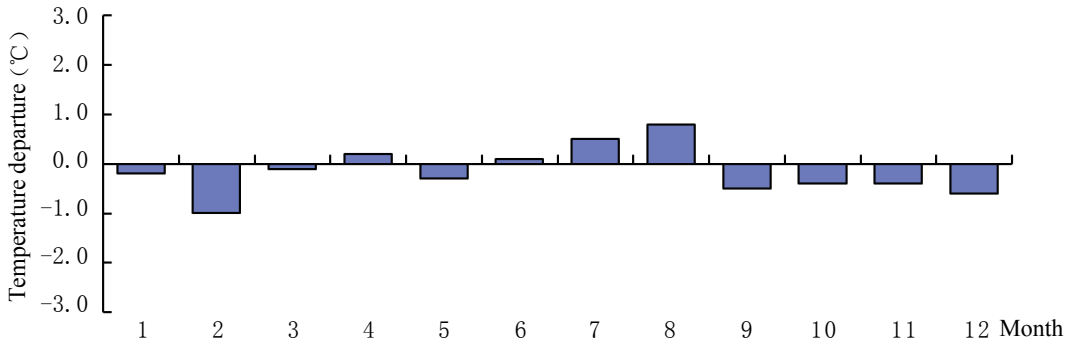



Figure 3–1 Departure of the mean monthly temperature of the Three Gorges Project area in 2012

The mean annual precipitation (MAP) of the project area registered 944.6 mm this year, down 16% from the historical average (1,122.5 mm). The MAP of local regions in the project area ranged between 768.8 mm and 1,104.4 mm, and geographical distribution analysis revealed vast discrepancy in precipitation among different regions. There was little precipitation in the central region, and much in the head and tail regions of the project area. The maximum MAP was recorded in Chongqing, and the minimum in Fengjie. The MAP recorded by local representative meteorological stations was on the low side compared with their respective historical average, except Chongqing Station recorded MAP approximate to the historical average. Among others, local MAP dropped 22%~33% in Fengjie, Zhongxian, and Wushan, 12%~19% in Yichang, Yunyang, Wanzhou, Changshou, Badong, and Fuling, and 5% in Fengdu and Zigui compared with historical average. Seasonal data indicated the mean seasonal precipitation was approximate to the seasonal historical average in the autumn, up 13% in the spring, down 26% in the winter, and down 40% in the summer. Monthly data demonstrated the mean monthly precipitation was up 28% in May and 32% in September, and down 18%~74% in January, February, June, July, August, October, November, and December compared with the monthly historical average. The mean monthly precipitation was abnormally below the monthly historical average in February and June, down 74% and 61% respectively. The mean monthly precipitation in the remaining months was approximate to the historical average.

The mean annual relative humidity (MARH) of the project area registered 74%, lower than the historical average (77%). The MARH of localities in the project area ranged between 65% and 86%. Wushan recorded the minimum value, while Zhongxian observed the maximum value. The MARH was above historical average in Zhongxian, Yunyang, and Zigui, and below in the rest regions. Among others, the MARH was significantly below historical average by up to 8% in Chongqing and Wanzhou. Seasonal data indicated the mean seasonal relative humidity was 71% in the winter, 74% in the spring, 73% in the summer, and 79% in the autumn. The relative humidity was much lower in the winter compared with average year, while the value in the spring, summer, and autumn was approximate to or a little lower than that of average year.

The mean annual evaporation (MAE) of the project area registered 1,135.6 mm, on the low side compared with historical average (1,225.3 mm). Geographical distribution analysis showed the local MAE was above 1,200 mm in Fuling, Fengjie, Wushan, and Yichang, over 1,300 mm in Wanzhou, and the maximum in Badong at 1,452.1 mm. The MAE of localities in the project area was generally on the low side compared with that

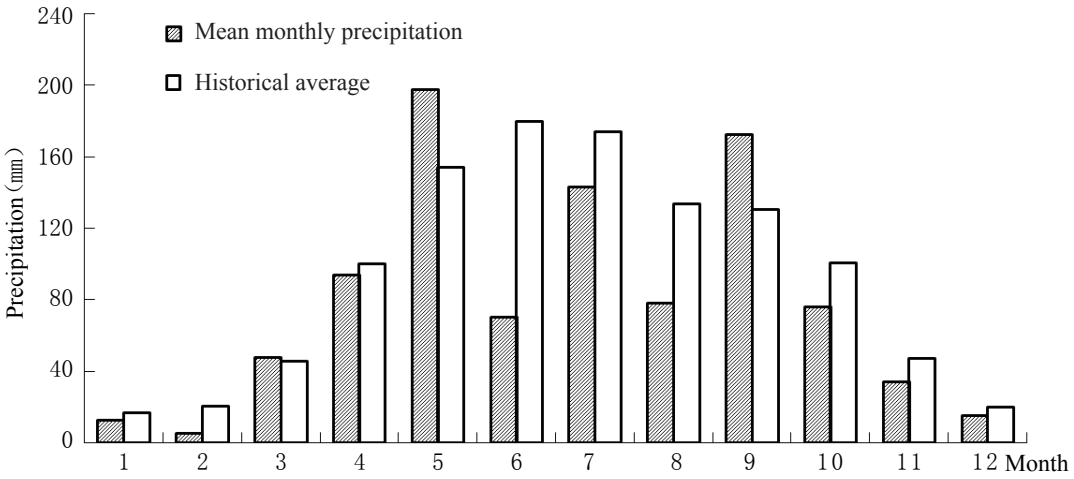



Figure 3–2 Comparison ofmean monthly precipitationin 2012 with the historical average in Three Gorges Project area

of average year. Seasonal data indicated significant fluctuations in mean seasonal evaporation, which was 124.6 mm in the winter, approximate to seasonal historical average; 276.0 mm in the spring, 18% lower than average year; 505.6 mm in the summer, 9% lower than average year; and 227.9 mm in the autumn, 25% lower than average year.

The mean annual wind speed (MAWS) registered 1.1 m/s in the project area, below the historical average (1.3 m/s). The MAWS was above 1.0 m/s in all localities except Fuling, Wushan, and Zigui. Badong recorded the maximum MAWS at 1.7 m/s, and Wushan the minimum at 0.5 m/s. Monthly data demonstrated little variation in the mean monthly wind speed, with the maximum value recorded in March and August at 1.3 m/s, and the minimum observed in October at 0.9 m/s. The mean monthly wind speed was either approximate to or lower (by 0.1~0.4 m/s) than the monthly historical average in 11 months except December when the data was up 0.1 m/s compared with average year.

The mean number of days with fog was 11 in the project area this year, down 27 days from the historical average, and reaching a historic low in the past 39 years. This data has been on the low side for eleven consecutive years since 2002 compared with the historical average. Geographical distribution analysis indicated Badong recorded up to 30 days with fog, the highest in the project area; Changshou 25 days; and other localities below 20 days. Among others, Wanzhou observed only one day with fog, and Yunyang and Wushan none. Zigui was above historical average in terms of mean number of days with fog, Badong and Yichang was approximate to historical average, and other localities was below historical average by over 50%. Among others, the recorded number of days with fog decreased by over 40 days in Changshou, Fuling, Fengdu, Zhongxian, and Wanzhou compared with historical average. Seasonal data indicated 1.6 days with fog were observed in the winter, 4.2 days in the spring, 2.3 days in the summer, and 2.7 days in the autumn, all far below seasonal historical average.

### 3.1.2 Meteorological hazards

The mainmeteorological hazards in the project area and the adjacent area this year were low temperature and continuous rain, rainstorm and flood, high temperature, drought, fog, and gale and hail.

**Low temperature and continuous rain:** The mean temperature in the project area and adjacent area registered 7.4℃ in 2011/2012 winter, 0.5℃ below the winter of average year. The majority of the localities recorded mean temperature which was remarkably lower than the historical average in winter. There were records of 6 spells of severe continuous rain and 75 spells of common continuous rain in Chongqing-based project area in the winter. The continuous low temperature, rain, and sparse sunlight delayed the developmental stage of winter wheat and rape in part of the project area by 5~9 days compared with average year; and caused

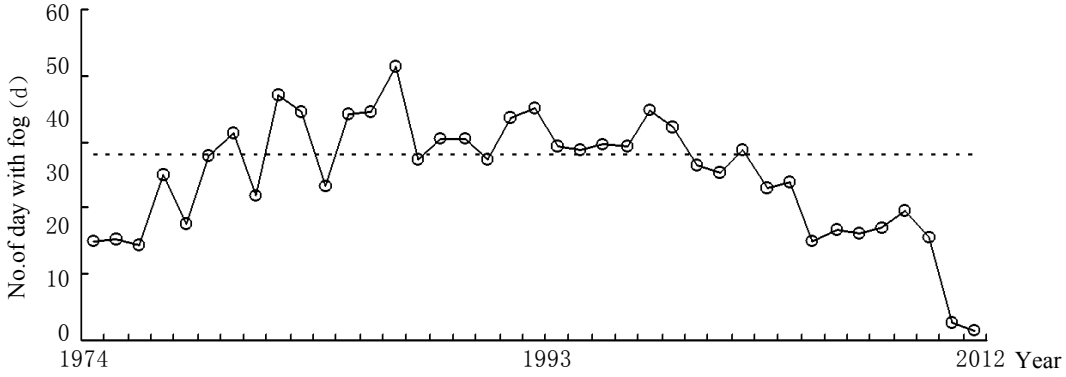



Figure 3–3 Variation of number of days with fog in Three Gorges Project area between 1974 and 2012

slow growth of field vegetables, greenhouse crops, and flowers and seedlings, undermined their disease resistance, reduced yields and affected produce quality. However, the continuous low temperature helped a lot suppress the survival of wintering pests.

**Rainstorm:** There were plenty of torrential rainfalls as well as landslides incurred in the project area and the adjacent area in the spring especially in May, claiming certain collateral deaths and injuries and economic losses. Part of the project area was struck by rainstorms in the summer, and the secondary disasters triggered by rainstorms resulted in 8.87 billion yuan of direct economic losses.

**High temperature:** The number of days with high temperature (maximum daily temperature≥35℃) ranged between 15 and 30 in the Three Gorges project area and adjacent area in the summer. The high temperature spells were mainly distributed between the last 10 days of July and the second 10 days of August, when most of the project area observed up to 10 to 20 days with high temperature, and part of Chongqing even recorded over 20 days with high temperature. The frequent high temperature events led to poor pollination of paddy fields, shortened grain filling stage, prevalent paddy rice maturity from high temperature, and decline in setting percentage and thousand kernel weight (TKW). In the meantime, the high temperature aggravated the aridity in some regions and adversely affected the seeding of crops in late autumn.

**Drought:** The precipitation in most of the project area and adjacent area was on the low side during January and February compared with average year. Meteorological drought emerged and developed in parts of the northeastern and southern Chongqing-based project area as well as western Hubei area. The monitoring data on meteorological drought on February 29 revealed moderate to severe drought in some parts of northeastern and southern Chongqing area.

Most parts of the project area and adjacent area observed less precipitation in the summer compared with the summer of average year. In the meantime, continuous high temperature lingered, for 15~30 days in eastern Hubei-based project area and Chongqing-based project area, up 3~10 days from historical average in summer. High temperature and little precipitation led to fast loss of soil moisture, resulted in droughts to varied extents, and somewhat affected local industry, agriculture, forestry, water resources, hydropower, ecological environment, and people's daily lives in part of the aforementioned areas.

**Heavy fog:** The number of days with fog was on the low side throughout the project area this year. However, periodical fog still appeared in the autumn and winter, which had adverse effects on the traffic. For example, the heavy fog smothering the western part of the project area on January 1 led to traffic control in multiple expressways, passengers fogbound in coach stations, road traffic and ferries disrupted, and 22 approaching flights headed for Chongqing airport forced to land on alternate airports of Chengdu Municipality and Guiyang Municipality, with hundreds of passengers fogbound at the airports. Moreover, heavy fog enveloped most of the project area on January 31, and part of the Yongchuan-Fuling leg of the mainstream of Yangtze River observed thick fog causing visibility below 500 m, forcing around

100 ships to dock in the city proper of Chongqing. Also, thick fog causing visibility below 500 m smothered Zigui County of Hubei Province, which is part of the Three Gorges project area, on November 27. Consequently, lots of vehicles lined up in fog at Yinxingtuo Pier, waiting for onboard.

**Gale and hail:** Zhongxian County of Chongqing Municipality was attacked by gale and hailstorm on April 24, which claimed one death (electrocuted by a fallen utility pole blown down by gales). Moreover, Fengdu County of Chongqing was struck by gale and hailstorm on May 8, which victimized 168,000 populations, claimed one death, forced 2,300 plus persons displaced hastily, had over 1,000 houses collapsed or destroyed, and resulted in more than 27 million yuan of direct economic losses. The severe convection weather events were on the low side in the project area in the summer compared with average year. The gale and hail hazards caused two deaths, one missing person, and over 75 million yuan of direct economic losses throughout the project area.

## 3.2 Forest resources

The forest area of the Three Gorges project area amounted to 2,685,400 ha. this year, with the forest coverage up to 46.57%. Among them, the closed forest lands occupied 2,555,700 ha., accounting for 95.17%; and shrub land specifically designated by the State amounted to 129,700 ha., taking up 4.83%. The living wood growing stock was 136,204,400 $m^3$, including 131,983,200 $m^3$ of forest growing stock which took up 96.90%; the growing stock of sparse wood land, scattered trees, and trees alongside villages, houses, pavements, and waters amounted to 4,223,500 $m^3$, taking up 3.10%.

Among the closed forest lands in the project area, natural forests occupied 1,847,500 ha., taking up 72.29%; and planted forests 708,200 ha., taking up 21.92%. Among the forest growing stock of the project area, natural forest growing stock was 103,051,900 $m^3$, accounting for 78.08%; and planted forest growing stock 28,931,300 $m^3$, taking up 21.92%.

Among the closed forest lands, the shelter forests covered 1,624,700 ha. (65.78%); special-purpose forests 130,100 ha. (5.27%); timber forests 589,300 ha. (23.86%); firewood forests 6,000 ha. (0.24%); and cash forests 119,900 ha. (4.85%). Among the forest growing stock, the growing stock of shelter forests amounted to 84,959,000 $m^3$ (64.37%), of special-purpose forests 10,004,500 $m^3$ (7.58%); of timber forests 36,936,200 ha. (27.99%); and of firewood forests 83,500 $m^3$ (0.06%).

Among the arbor forests, the sapling forests covered 1,026,600 ha. (41.56%), and their growing stock amounted to 37,898,200 $m^3$ (28.71%); the half-mature forests 1,017,900 ha. (41.21%), and their forest growing stock 60,803,200 $m^3$ (46.07%); the near-mature forests 317,100 ha. (12.84%), and their forest growing stock 22,230,000 $m^3$ (16.84%); the mature forests 95,200 ha. (3.85%), and forest growing stock 9,469,200 $m^3$ (7.17%); overmature forests 13,200 ha. (0.53%), and forest growing stock 1,582,500 $m^3$ (1.20%). The arbor forests in the project area were dominated by sampling forests and half-mature forests, the combined area of which accounted for 82.78% of the total forest area, and the combined forest growing stock took up 74.78%.

The planted forests covered 307,200 ha. in the project area between 2011 and 2012, and 297,400 ha. was preserved, so the survival rate reached 96.81%. Among others, the planted forests amounted to 170,700 ha. in the year 2011, and 166,400 ha. was preserved, with survival rate at 97.49%; the planted forests reached 136,500 ha. in the year 2012, and 131,000 ha. survived, with survival rate at 95.95%.

A total of 80,100 ha. forests suffered from forest hazards between 2011 and 2012, accounting for 2.98% of the total forest area in the project area, including 79,800 ha. struck by forest diseases and insect pests, and 300 ha. by forest fires.

## 3.3 Terrestrial plants

### 3.3.1 Main vegetation types and species composition of plant community

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 absolute dominant species there.

The geographical distribution of all types of vegetation

*Invasive plant of the project area Eichhornia crassipes*

was affected by a 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 coniferous 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.

**3.3.2 Census on invasive alien plant species**

Census was carried out on invasive alien plant species along the banks of the Yangtze River mainstream (from head region through tail region) and sideways of primary highways in the project area this year.

Up to 72 invasive alien plant species which belonged to 21 families were identified during the census this year. There were 20 species of Asteraceae, followed by Leguminosae (12species) and Amaranthaceae (8species), then Poaceae (5species), Solanaceae (5species), Euphorbiaceae (3species), Apiaceae (3species), Cactaceae (2species), Scrophulariaceae (2species); and finally, Plantaginaceae, Chenopodiaceae, Onagraceae, Basellaceae, Verbenaceae, Portulacaceae, Geraniaceae, Phytolaccaceae, Myrtaceae, Pontederiaceae, Nyctaginaceae, and Oxalidaceae, each with one species. Among others, there were 70 terrestrial plant species, one aquatic species and one amphibian species; 68 herbaceous or suffrutex plant species, and 4 ligneous plant species. Nine out of the 72 identified invasive alien plant species in the project area were announced as worst invasive alien species, which included *Eichhornia crassipes, Sorghum halepense* (L.) Pers., *Alternanthera philoxeroides, Ageratina adenophora, Amaranthus spinosus, Solidago Canadensis, Anredera cordifolia, Lantana camara, and Dysphania ambrosioides.*

Analysis of the geographical distribution of the invasive alien plant species in the districts (counties) of the project area indicated there were 3 local districts (counties) where over 50 invasive alien plant species were identified, that is, Wanzhou (54), Jiangjin (54), and Shizhu (53); and 5 districts (counties) where 40~49 such species were identified, that is, Fuling (48), Changshou (46), Wulong (44), Badong (42), and Fengdu (42). As for the remaining districts (counties), 39 invasive alien plant species were identified in Zhongxian, 39 in Chongqing city proper (including Yuzhong District, Dadukou District, Jiangbei District, Shapingba District, Jiulongpo District, and Nan'an District), 38 in Wushan, 36 in Zigui, 36 in Fengjie, 35 in Kaixian, 32 in Xingshan, Yunyang, and Yubei, 30 in Wuxi, 27 in Banan, and 22 in Yiling District of Yichang Municipality.

The invasive alien species in the project area were distributed in regions with certain degree of disturbance, 47.3% in regions with severe disturbances, 44.0% in regions with moderate disturbances, and only 8.7% in regions with slight disturbances.

## 3.4 Terrestrial animals

There had been 694 species of terrestrial wild vertebrates in the project area by the end of the year, which fell into 336 genera, 110 families, 30 orders, and 4 classes. Among others, there were 112 Mammalia species in 74 genera, 25 families, and 8 orders, 487 Aves species in 210 genera, 65 families, and 18 orders, 51 Reptilia species in 35 genera, 11 families, and 2 orders, and 44 Amphibia species in 17 genera, 9 families, and

*A captured Anas penelope*

2 orders. There were 93 wild animal species under state key protection, including 15 species under I-level state key protection and 78 species under II-level state key protection.

No obvious variations were observed in the general population and community structure of the terrestrial wild vertebrates, but the population of several species varied significantly. The census on wintering water birds identified 956 *Phalacrocorax carbo*, up 164.82% from a year earlier; 3,764 *Anas platyrhynchos*, up 25.68%; 2,310 *Anas poecilorhyncha*, up 12.29%; 777 *Anas Penelope*, down 45.74%; 691 *Tachybaptus ruficollis*, down 4.95%; and 141 *Fulica atra*, down 86.24%. The project area had already been an important habitat for wintering water birds. Among others, *Tachybaptus ruficollis* were mainly distributed in the tributary rivers of Yangtze River, and *Anas platyrhynchos* were mainly distributed in the mainstream of Yangtze River.

## 3.5 Rare and endemic aquatic animals

### 3.5.1 Endemic fish species

Up to 119 fish species were identified in the Yibin-Yichang reach of Yangtze River this year, including 23 fish species endemic to the upstream of Yangtze River and 9 alien species. There was no evident variation in the number of endemic fish species in the upstream reaches including Yibin reach and Hejiang reach before and after the impoundment of the Three Gorges Reservoir. However, the number dropped significantly in the project area.

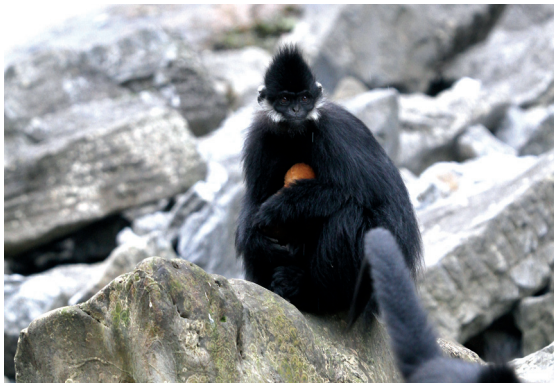
A total of 43,553 sample fishes weighing 1,962.93 kg were caught for the survey on fish catches. There were 5,500 endemic fishes which weighted 294.97 kg, accounting for 12.6% of the total number, and down a little from last year; and 15.0% of the total weight, up a little from last year. Analysis of fish resources indicated there were still endemic fish populations of certain size identified in upstream reaches such as Yibin reach and Hejiang reach as well as Mudongjiang reach in the downstream of the project area after the impoundment of the Reservoir. However, very few endemic fish species were found in reaches such as Wanzhou reach in the central region of the project area, Zigui reach in the head region and Yichang reach in the downstream of the Three Gorges Dam.

Experiment was carried out on the artificial propagation of *Megalobrama pellegrini*, a fish species endemic to the upstream of Yangtze River, and 800,000 alevins were born through scaled spawning induction.

### 3.5.2 Rare aquatic animals

In 2012, the sonar detecting data showed thereproductive population of Chinese sturgeon (*Acipenser sinensis* Gray) was mainly distributed in the Yangtze River reach between Gezhouba Dajiang Power Plant and Yanshouba, and two spawning occasions were detected. Calculated from the sonar detecting data, there were 165 reproductive Chinese sturgeons before the spawning, 120 after the first spawning, and 83 after the second spawning. The reproductive population before the spawning was somewhat downsized compared with last year. 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



*Trachypithecus francoisi*

and effective number of alleles per locus of the juvenile Chinese sturgeon populations, and the mean observed heterozygosity was 0.98, the mean expected heterozygosity 0.78, and the mean Hardy-Weinberg departure value 0.27. No obvious differences were observed regarding the above indexes between this year and last year.

According to the estimates based on the survey data on Yichang-Shanghai reach of mainstream Yangtze River, Poyang Lake and Dongting Lake, there were about 1,000 *Neophocaena phocaenoides* living in the Yangtze River Basin, much less than the data of 2006. Among others, there were around 450 *Neophocaena phocaenoides* in Poyang Lake and 90 in Dongting Lake. Affected by increasingly busy river traffic and diminishing fish resources, the *Neophocaena phocaenoides* populations were distributed randomly in Yangtze River, mainly in unnavigable waterways, and riverside wharfs with relatively abundant fish resources. No *Lipotes vexillifer* was ever observed in this year's survey.

## 3.6 Agroecology

### 3.6.1 Ecological environment of farmland

The farmland in the project area totaled 410,812 ha. this year, going up to some extent from a year earlier. Among others, the increment of dry-land area was most drastic. Analysis of the composition of farmland area indicated arable lands accounted for 66.8% of the total area, including dry lands (40.4%) and paddy fields (26.4%); and gardens took up 33.2%, including citrus orchards (18.9%), tea gardens (3.1%), traditional Chinese medicine gardens (0.7%), and others (10.5%).

Analysis of the tillage system showed 37.7% of the dry lands practiced triple-cropping system, 50.1% double-cropping system, and 12.2% one-cropping system. The percentage of dry lands practicing triple- and one-cropping system went down compared with last year, as opposed to those practicing double-cropping system. As for the paddy fields, the area practicing triple-cropping system accounted for 12.2%, double-cropping system 53.4%, and one-cropping system 34.4%. The percentage of paddy fields with double-cropping system went down compared with last year, as opposed to those with triple-and one-cropping systems.

Analysis of slope gradient of the farmlands (paddy fields excluded) showed, the area of farmlands with slope gradient below 10º accounted for 17.7% of total area; 10º~15º (28.6%); 15º~25º (31.3%); and above 25º (16.6%). Analysis of farmland altitude indicated, the area of farmlands with altitude below 500 m accounted for 47.1% of the total area, 500~800 m (36.0%); 800~1,200 m (14.2%); and above 1,200 m (2.7%). A total of 5,724 ha. of slope farmlands were transformed into terraces, and up to 11,524 ha. farmlands were returned to forests and grasslands.

The sown area of crops totaled 702,678 ha., which included grain crops (68.2%) and cash crops (31.8%). The multiple cropping index was 256%. The share of grain crops was up and that of cash crops was down compared with last year.

### 3.6.2 Rural energy

Up to 6.868 million t of firewood was consumed throughout the project area this year, with per capita firewood consumption of 7.1 t, the same as last year. There were up to 245,141 biogas pools in rural households, with combined annual biogas output of 97.438 million $m^3$. The equivalence was 15.6 pools per 100 households, and it was a decrease from a year earlier. Moreover, the energy mix of the project area also included 3.216 million t of stalks, 174,147,000 kW of small hydropower, and 904,000 t of coal from small kilns.

### 3.6.3 Crop disease and insect pests

Crop disease and insect pests struck crops for up to 436,000 ha.•times in the project area this year, of which 362,667 ha.•times were put under control and management. Up to 192,335 t of grain was retrieved from insect pests and diseases, the actual loss of grain totaled 56,696 t, and the economic losses amounted to 102.61 million yuan. Analysis of crop species indicated potatoes were hit hardest by epidemic diseases, while wheat encountered slight disease and insect pests. Analysis of insect pest and crop disease varieties showed rice planthopper, maize sheath blight, Plutella xylostella, and potato late blight wrecked greater havoc.

Table 3–2 Crop disease, insect pests, and rat hazards of staple crops in the Three Gorges Project area in 2012

| Crop disease/insect pest | Epidemic area (ha.•times) | Area under Control(ha.•times) | Loss retrieved (t) | Actual loss (t) | Economic loss (10,000 yuan) |
|---|---|---|---|---|---|
| Rice planthopper (paddy rice) | 68,000 | 73,333 | 41,259 | 6,953 | 1,638 |
| *Cnaphalocrocis medinalis* | 26,667 | 24,000 | 8,026 | 1,887 | 432 |
| Sheath blight (paddy rice) | 22,667 | 21,333 | 4,906 | 1,158 | 265 |
| Rice blast | 12,000 | 10,667 | 1,459 | 2,573 | 18 |
| Wheat stripe rust | 10,667 | 9,333 | 2,194 | 481 | 193 |
| Wheat scab | 6,000 | 6,667 | 1,247 | 319 | 54 |
| Wheat powdery mildew | 10,000 | 10,000 | 1,531 | 429 | 70 |
| Sheath blight (wheat) | 10,000 | 7,333 | 1,050 | 1,172 | 130 |
| Wheat aphid | 8,000 | 8,000 | 1,151 | 231 | 44 |
| Maize borer | 32,000 | 30,667 | 10,567 | 1,897 | 419 |
| Sheath blight (maize) | 33,333 | 26,000 | 6,128 | 2,755 | 485 |
| Northern and southern leaf blight of maize | 10,667 | 10,667 | 1,546 | 647 | 135 |
| Rape sclertiniose | 10,667 | 8,000 | 1,322 | 968 | 708 |
| Rape aphid | 8,000 | 8,000 | 895 | 238 | 98 |
| Potato late blight | 22,667 | 20,000 | 20,923 | 5,155 | 654 |
| Vegetable aphid | 20,667 | 22,667 | 23,026 | 6,031 | 1,024 |
| PierisrapaeLinne, Plutella xylostella | 20,667 | 22,667 | 18,365 | 4,424 | 749 |
| Liriomyza sativae | 6,000 | 7,333 | 5,657 | 3,008 | 551 |
| Vegetable mites | 4,000 | 6,000 | 3,570 | 1,938 | 303 |
| Downy mildew (vegetables) | 14,000 | 15,333 | 8,236 | 2,599 | 547 |
| Vegetable blight | 6,000 | 8,667 | 5,735 | 1,614 | 327 |
| Other vegetable pests and diseases | 16,000 | 15,333 | 7,919 | 3,242 | 598 |
| Rat | 57,333 | 36,000 | 15,623 | 6,977 | 819 |
| Total | 436,000 | 362,667 | 192,335 | 56,696 | 10,261 |

## 3.7 Fishery resources and environment

### 3.7.1 Fishery resources

The natural fish catches in the Three Gorges project area, the downstream of Three Gorges Dam, Dongting Lake, Poyang Lake, and estuary totaled 55,500 t this year, up 19.3% from a year earlier. The larvae flow of four major Chinese carps (*Mylopharyngodon piceus, Ctenopharyngodon idellus, Hypophthalmich-thyus molitrix, Aristichthys nobilis*) amounted to 397 million in Jianli Section in the downstream of the Dam, some increment from a year earlier. The natural catches of *Coilia mystus*, elver, and parent crab decreased to varied degrees compared with last year.

● **Project area**

The natural fish catches in the project area registered 5,917 t this year, up 29.5% from a year earlier. Calculated by the species of the catches, *Silurus asotus* weighted 1,449 t, *Cyprinus carpio* 1,214 t, *Coreius heterokon* 1,043 t, *Hypophthalmich-thyus molitrix* 645 t, *Ctenopharyngodon idellus* 172 t, and *Pelteobagrus fulvidraco* 167 t. The combined weight of the aforementioned six fish species accounted for 79.3% of the total weight of the sample catches, and they are the major cash fish species in the project area.

The sonar detection results of four reaches revealed the mean fish density was 73.92/1,000 $m^3$ in the upstream of the Dam, 57.25/1,000 $m^3$ in Wushan, 17.71/1,000 $m^3$ in Yunyang, and 37.94/1,000 $m^3$ in Fuling.

● **Downstream of the Dam**

The natural fish catches amounted to 1,570 t in the downstream of the Dam this year, up 17.2% from a year earlier. Calculated by the species of the catches, there were 554 t of *Cyprinus carpio*, 336 t of four major Chinese carps, 103 t of *Silurus asotus*, 115 t of *Parabramis pekinensis*, 72 t of *Coreius heterokon*, 50 t of *Pelteobagrus fulvidraco*, and 47 t of *Carassius auratus*. The combined weight of the above mentioned fish species accounted for 81.3% of the total weight of the sample catches, and they are the major cash fishes in the downstream of the dam.

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

Jianli Section in the downstream of the Dam recorded 397 million larvae of four major Chinese carps between May and July, some increment from a year earlier. *Hypophthalmich-thyus molitrix* and *Ctenopharyngodon idellus* were the dominant species among the four major Chinese carps, taking up 75.4% and 18.7% respectively, and as before, there were very few *Mylopharyngodon piceus* and *Aristichthys nobilis* which together took up 5.9%.

Up to 199 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 scale which has been on the rise in recent years.

● **Dongting Lake**

The natural fish catches was 21,200 t in Dongting Lake, up 15.8% from a year earlier, including 9,300 t (43.9%) from eastern lake, 7,500 t (35.4%) from southern lake, and 4,400 t (20.7%) from western lake. Among the fish catches, settled fishes including *Cyprinus carpio, Carassius auratus, Silurus asotus*, and *Parabramis pekinensis*, together with four major Chinese carps, accounted for 74.5% of the total catches, and are the major cash fishes of Dongting Lake.

● **Poyang Lake**

The natural fish catches was 26,800 t in Poyang Lake this year, up 20.2% from a year earlier. Among the fish catches, settled fishes including *Cyprinus carpio, Carassius auratus, Silurus asotus*, and *Pelteobagrus fulvidraco*, together with four major Chinese carps, accounted for 77.7% of the total catches, and are the major cash fishes of Poyang Lake.

● **Yangtze River estuary**

The *Coilia mystus* monitoring ships were in fishing operations for a longer span of time than last year in the Yangtze River estuary during the fishing season, and the parent crabs and elver monitoring ships worked for about the same days as last year. On average, the count of working days of *Coilia mystus*, parent crab and elver monitoring ships throughout the fishing season was all less than that of last year.

The catch of *Coilia mystus* per ship averaged 130.0 kg, while the total catch amounted to 8.2 t throughout the fishing season, down 64.7% compared with the same period last year and reaching the record low since 1997. The output of *Coilia mystus* per ship averaged 7,815 yuan, down 61.0% from a year earlier. The average length of *Coilia mystus* was 152 mm, a year-on-year increase by 4.8%, and the average weight 14.7 g, a year-on-year increase by 9.7%.

*Monitoring geological hazards by GPS*

The total catch of parent crabs amounted to 28.0 t in the fishing season, a year-on-year decrease by 10.3%. The average height and width of crab shell recorded 62 mm and 67 mm respectively, and the average weight of the crab was 143 g. All of the three parameters were a little lower than those of the same period last year.

The catch of elver per ship amounted to 8,162 ones throughout the fishing season, down 56.28% compared with the same period last year. The output per ship was 247,881 yuan, a year-on-year increase by 18.5%. The total catch of elver was 1.52 t throughout the fishing season, down 35.9% from a year earlier.

The count of fishing permits issued for *Coilia mystus* and for parent crabs was about the same as last year, and the count of permits issued for elver dropped by 136 ones from a year earlier.

**3.7.2 Environment of fishery waters**

Seven monitoring stations (Yibin, Banan, Wanzhou, Jingzhou, Yueyang, lake outlet, and estuary) were established in the mainstream of Yangtze River, Dongting Lake, Poyang Lake, and Yangtze River estuary this year to monitor the water quality of important fishery waters in the Yangtze River basin. The evaluation of water quality shall comply with *Water quality standard for fisheries (GB11607-89)*, and monitoring items not stipulated by this standard shall be evaluated in accordance with relevant requirements for functional waters provided by *Environmental Quality Standards for Surface Water (GB3838-2002)*. The monitoring data indicated the water quality of important fishery waters in Yangtze River basin was good in general during the reproductive season, finishing 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 copper and Un-ionized Ammonia (UIA).

● **Upstream of Yangtze River**

The main pollutant in Yibin waters was copper, which was over the water quality standard by 100.0% during the wintering season, reproductive season, and finishing period of the fishes; other monitoring items attained water quality standards. There was no obvious variation in the copper concentration, but the UIA concentration was dropping compared with last year. The main pollutant in Banan waters was also copper, which was over the standard by 100.0% during the wintering season, reproductive season, and finishing period; the UIA concentration was over the standard by 100.0% during the reproductive season; and other monitoring items attained water quality standards. There was no obvious variation of concentration of the monitoring items compared with last year. All of the monitoring items in Wanzhou waters attained water quality standards, and there was no obvious variation in the concentration of monitoring items compared with last year.

● **Midstream of 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 last year.

The UIA concentration in Chenglingji waters was over the standard by 33.3% during the wintering season, and by 66.7% during the finishing period, an increase from last year.

The copper concentration at lake outlet was over the standard by 33.3% during the wintering season, and the concentration of lead and $Cr6^{+}$ decreased compared with that of last year.

● **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 remarkable variations compared with last year.

● **Spawning sites of 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. The UIA concentration dropped to some extent compared with the same period last year.

● **Dongting Lake**

The UIA concentration of Dongting Lake was over the standard by 25.0% during the reproductive season, and by 33.3% during the finishing period; other monitoring items attained water quality standards. The mercury and copper concentration decreased to some extent, while other monitoring items recorded no obvious variations compared with the same period last year.

● **Poyang Lake**

The copper content of Poyang Lake was over the standard by 33.3% during the wintering season of fishes. Other monitoring items attained water quality standards. The copper and lead content dropped to some extent compared with the same period last year.

● **Yangtze River estuary**

All the monitoring items attained water quality standards. The concentration of petroleum pollutants declined to some extent compared with the same period last year.

## 3.8 Earthquake and geological hazard

### 3.8.1 Earthquake

There were 573 recorded earthquakes (M≥0.0) all over the project area this year, up 160 occurrences from a year earlier, including 441 earthquakes rated 0.0≤M<1.0, up 37.4%/120 occurrences from a year earlier; 117 rated 1.0≤M<2.0, up 42.7%/35 occurrences; 12 rated 2.0≤M<3.0, up 20.0%/2 occurrences; and 3 rated 3.0≤M<3.9, up 3 occurrences. Among others, there was one moderate earthquake (M3.2) shaking Zigui County, Hubei Province at 03:42 on October 31. The earthquakes were more active and intensive than last year, which was mainly attributed to the M3.2 earthquake swarm striking Zigui County as of October 31. The seismic activities were on the same level as last year in other part of the project area, mainly minor and micro earthquakes. The recorded earthquakes were distributed along the Yangtze River reach between Wushan County of Chongqing and

Table 3–3 Statistics on earthquake eventsfromthehead region through central region of the Three Gorges Project area between 2011–2012

| Year / Magnitude/M | 2011 | | 2012 | |
|---|---|---|---|---|
| | Year (occurrence) | Monthly average | Year (occurrence) | Monthly average |
| 0.0～0.9 | 321 | 26.75 | 441 | 36.75 |
| 1.0～1.9 | 82 | 6.83 | 117 | 9.75 |
| 2.0～2.9 | 10 | 0.83 | 12 | 1.00 |
| 3.0～3.9 | 0 | 0 | 3 | 0.25 |
| 4.0～4.9 | 0 | 0 | 0 | 0 |
| Total (occurrence) | 413 | | 573 | |
| Max. M | 2.7 | | 3.2 | |

### 3.8.2 Metrological hazards

About 4,000 monitoring staff was mobilized to monitor and prevent geological hazards throughout the project area this year as one of the public participation initiatives. Also, 106 monitoring technicians engaged in the monitoring work for early warning purposes. The public participated monitoring program carried out 183,000 times of monitoring assignments; and the monitoring technicians conducted 44,000 times, including 27,000 times by global positioning system, 13,000 times through monitoring holes, and 3,900 times with geological inspection tours. All those efforts helped issue early warnings on geological hazards and risks in a timely fashion.

*Automatic monitoring of Landslides*

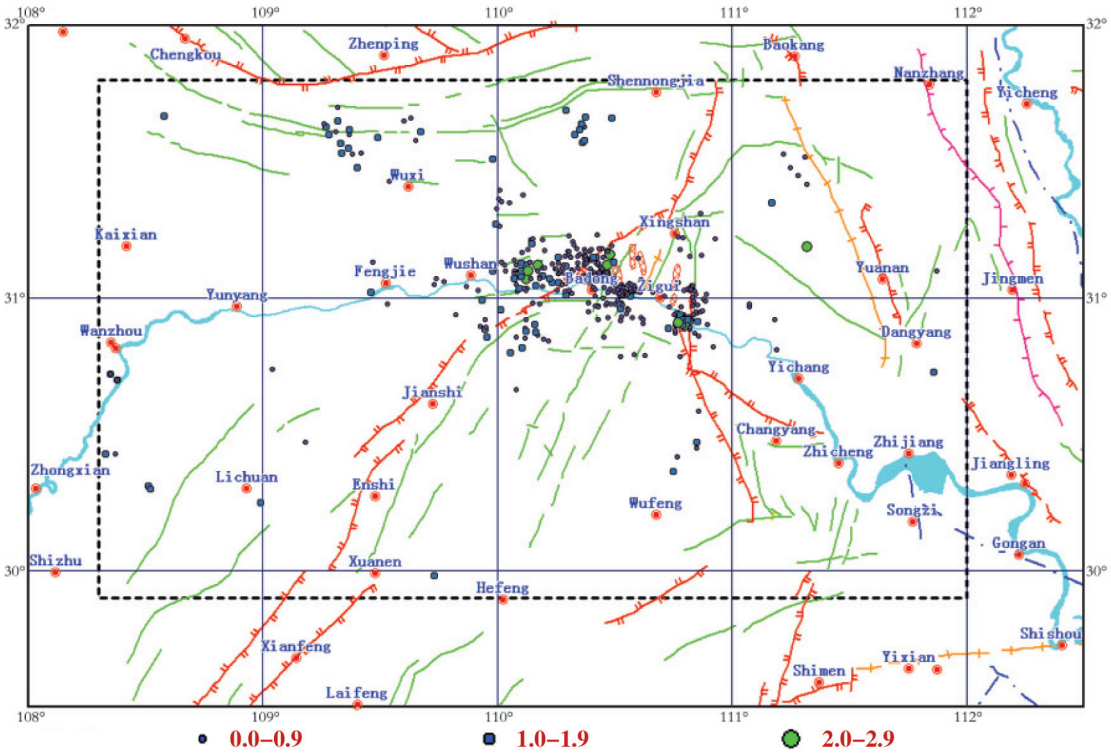



Figure 3–3 Map of epicenters from the head region through central region of Three Gorges Project area in 2012

A total of 52 deformed landforms prone to collapses and landslides as well as actual collapses and landslides were identified throughout the project area, including 17 sites in Hubei-based project area and 35 in Chongqing area. From the perspective of deformation degree, alert (blue-color early warning) was issued for 9 pending collapses and landslides, and caution (yellow-color early warning) was issued for 2 pending landslides (Shuping Landslide in Zigui County, and No.1 Landslide in Tangjiao Village, Wanzhou District). Two landslides (Zengjiaping Landslide and Huanglianshu Landslide in Fengjie County) caused massive damages after the early warning was issued.

The Three Gorges Project carried out its fifth EL.175m trial impoundment this year. The amount of deformed landscapes prone to geological hazards went down 32.5% from a year earlier while the reservoir maintained high water levels, and down 11.9% from 2003 baseline when the reservoir commenced impoundment. The amount was on the decline for a period. The main inducements of geological hazards included rainfalls, water level fluctuations of the reservoir, and project activities.

# Chapter 4
# Pollutant Load of Pollution Sources

## 4.1 Industrial wastewater pollutants

The wastewater discharged by industrial pollution sources amounted to 173 million t in the project area this year, a year-on-year decrease of 9.5%; including 142 million t (82.1%) from Chongqing-based project area and 31 million t (17.9%) from Hubei-based project area. The wastewater contained 33,100 t of COD and 2,000 t of ammonia nitrogen.

Table 4–1 Statistics on industrial wastewater discharged in the Three Gorges Project area in 2012

| Region | | Wastewater (100 mil. t) | COD (10,000 t) | Ammonia nitrogen (10,000 t) |
|---|---|---|---|---|
| Hubei-based project area | | 0.31 | 0.56 | 0.02 |
| Chongqing-based project area | | 1.42 | 2.74 | 0.18 |
| Total | | 1.73 | 3.31 | 0.20 |
| Among others | Chongqing city proper | 0.45 | 0.41 | 0.03 |
| | Changshou District | 0.27 | 0.26 | 0.01 |
| | Fuling District | 0.13 | 0.56 | 0.02 |
| | Wanzhou District | 0.14 | 0.46 | 0.06 |

## 4.2 Municipal pollutants

**4.2.1 Municipal sewage**

The municipal sewage discharged across the project area amounted to 731 million t this year, a year-on-year increase of 3.6%, including 694 million t (94.9%) from Chongqing-based project area and 37 million t (5.1%) from Hubei-based project area. The municipal sewage contained 142,400 t of COD and 24,800 t of ammonia nitrogen.

**4.2.2 Municipal waste**

Up to 3,354,900 t of municipal waste was generated by 15 local districts/counties in the project area this year, 2,944,800 t of which was disposed, accounting for 87.8%, and 410,100 t was directly discharged into the environment, taking up 12.2%.

**4.2.3 Municipal wastewater treatment plant**

There were 103 urban municipal wastewater treatment plants throughout the project area this year, with designed treatment capacity totaling 2,394,700 t/day. A total of 708 million t of wastewater was treated all over the year.

## 4.3 Agricultural non-point pollution

**4.3.1 Application and loss of pesticides**

A total of 701.3 t of pesticides (pesticide equivalent) was applied in 19 districts (counties) in the Three Gorges Project area this year, about the same as last year. The organic phosphorus pesticide accounted for 45.6% of the total applied pesticide, carbamates pesticide 14.3%, pyrethroid pesticide 8.3%, herbicides 18.0%, and others 13.8%. The pesticide equivalent per hectare of farmland amounted to 1.7 kg.

From the perspective of pesticide loss, 44.5 t of pesticide was lost throughout the year in the project area, about the same as last year. Among others, the organic

Table 4–2 Statistics on municipal sewage discharged in the Three Gorges Project area in 2012

| Region | | Sewage (100 mil. t) | COD (10,000 t) | Ammonia nitrogen (10,000 t) |
|---|---|---|---|---|
| Hubei-based project area | | 0.37 | 0.69 | 0.12 |
| Chongqing-based project area | | 6.94 | 13.55 | 2.36 |
| Total | | 7.31 | 14.24 | 2.48 |
| Among others | Chongqing city proper | 3.98 | 4.76 | 1.14 |
| | Changshou District | 0.27 | 0.69 | 0.12 |
| | Fuling District | 0.39 | 1.19 | 0.15 |
| | Wanzhou District | 0.56 | 1.50 | 0.22 |

Table 4–3 Survey data of municipal waste in some districts/counties in the Three Gorges Project area in 2012

| District/county | Permanent urban population (10,000) | Generated (10,000 t) | Disposed (10,000 t) | Directly discharged (10,000 t) |
|---|---|---|---|---|
| Jiangjin | 35.8 | 13.78 | 11.72 | 2.07 |
| Chongqing city proper | 556.74 | 214.34 | 192.91 | 21.43 |
| Changshou | 29.4 | 11.32 | 9.62 | 1.7 |
| Fuling | 53.2 | 20.48 | 17.41 | 3.07 |
| Wulong | 5.88 | 2.26 | 1.86 | 0.41 |
| Fengdu | 13.3 | 5.12 | 4.2 | 0.92 |
| Zhongxian | 15.33 | 5.9 | 4.84 | 1.06 |
| Wanzhou | 74.8 | 28.8 | 24.48 | 4.32 |
| Yunyang | 18.03 | 6.94 | 5.69 | 1.25 |
| Kaixian | 24.6 | 9.47 | 7.77 | 1.7 |
| Fengjie | 18.76 | 7.22 | 5.92 | 1.3 |
| Wushan | 8.82 | 3.4 | 2.78 | 0.61 |
| Badong | 5.35 | 2.06 | 1.69 | 0.37 |
| Xingshan | 3.93 | 1.51 | 1.24 | 0.27 |
| Zigui | 7.49 | 2.88 | 2.36 | 0.52 |
| Total | 871.43 | 335.49 | 294.48 | 41.01 |

Table 4–4 Statistics on urban municipal wastewater treatment plants in the Three Gorges Project area in 2012

| Region | No. of municipal wastewater treatment plants | Designed treatment capacity (10,000 t/d) | Wastewater treated in the year (100 mil. t) |
|---|---|---|---|
| Hubei-based project area | 19 | 14.08 | 0.34 |
| Chongqing-based project area | 84 | 225.39 | 6.74 |
| Total | 103 | 239.47 | 7.08 |

phosphorus pesticide loss accounted for 57.3% of the total loss, carbamates loss 11.2%, pyrethroid loss 6.5%, herbicide loss 14.2%, and others 10.8%.

**4.3.2 Application and loss of chemicalfertilizers**

A total of 157,000 t of chemical fertilizers (fertilizer equivalent) were applied throughout the project area this year, up 1.9% from a year earlier. Among others, nitrogen fertilizers accounted for 59.9%, phosphorus fertilizers 29.3%, and potassium fertilizers 10.8%. The fertilizer equivalent per hectare amounted to 0.38 t in the project area.

From the perspective of loss of fertilizers, up to 12,500 t of fertilizers were lost in the project area throughout the year. Among others, the nitrogen fertilizers accounted for 75.2% of the total loss, phosphorus fertilizers 18.4%, and potassium and compound fertilizers 6.4%. Up to 30.4 kg of fertilizers were lost per hectare in the project area.

## 4.4 Ship pollutants

There were 8,215 registered ships across the project area this year, down 86 from a year earlier. However, the gross tonnage of the ships was up 8,700 t. There was no record of ship pollution incident within the administrative jurisdiction of Three Gorges Project area this year.

**4.4.1 Oil-contaminatedwater**

A total of 416 ships were sampled for the survey on oil-contaminated water discharged by engine rooms of ships registered in the project area this year, and 90.9% of them attained discharge standards. Analysis of ship type showed the attainment rate in descending order for all types of ships for discharge of oil-contaminated water was 95.5% for non-transport ships, 91.8% for passenger boats, 90.7% for freight boats, and 77.8% for tugboats. The attainment rate of passenger boats and freight boats for discharge of oil-contaminated water was up 4.8% and 12.7% respectively from a year earlier, and that of tugboats and non-transport ships was down 22.2% and 4.5% respectively. Analysis of ship power indicated the 1st ranking ships (P＞1,500 kW) recorded the maximum attainment rate (up to 96.7%) for discharge of oil-contaminated water; the 2nd ranking ships (441kW≤P＜1,500 kW) reached 92.6% of attainment rate; and the 4th ranking ships (36.8kW≤P＜147 kW) and 5th ranking ships (P＜36.8 kW) recorded attainment rate at 85.7%. The 3rd ranking ships (147 kW≤P＜441kW) observed the minimum attainment rate at 85.0%.

Estimated by the registered ship population, up to 510,200 t of oil-contaminated water was discharged throughout the project area this year, of which 487,100 t was disposed, accounting for 95%. Up to 437,700 t of oil-contaminated water attained discharge standards after disposal, taking up 86%. The amount of discharged oil-contaminated water was up by 14,300 tons from a year earlier, while the attainment rate was up 1%. Among all types of ships, freight boats discharged the most oil-contaminated water (262,200 t), followed by passenger boats (157,100 t), and then non-transport boats (72,400 t), and finally tugboats (18,400 t), which accounted for 51.4%, 30.8%, 14.2% and 3.6% respectively of the total.

Of the oil-contaminated water, petroleum-contaminated water recorded 467,500 t, up by 1.50 t from the previous year. Among all types of ships, passenger boats discharged the most petroleum-contaminated water, which was 24.36 t (52.1%);

Table 4–5 Oil–contaminated water discharged by ships in the Three Gorges Project area in 2012

| Ship | | Oil-contaminated water | | | | | | Petroleum-contaminated water | |
|---|---|---|---|---|---|---|---|---|---|
| Type | No. | Discharged (10,000 t) | Pct. (%) | Disposed (10,000 t) | Disposal rate (%) | Attainment amount (10,000 t) | Attainment rate (%) | Discharged (t) | Pct. (%) |
| Passenger | 2327 | 15.71 | 30.8 | 15.40 | 98 | 14.77 | 94 | 24.36 | 52.1 |
| Freight | 4035 | 26.22 | 51.4 | 24.39 | 93 | 20.72 | 79 | 20.24 | 43.3 |
| Tugboat | 191 | 1.84 | 3.6 | 1.82 | 99 | 1.69 | 92 | 0.28 | 0.6 |
| Non-transport | 1662 | 7.24 | 14.2 | 7.10 | 98 | 6.59 | 91 | 1.87 | 4.0 |
| Total | 8215 | 51.02 | 100 | 48.71 | 95 | 43.77 | 86 | 46.75 | 100 |

followed by freight boats, 20.24 t (43.3%); then non-transport ships, 0.28 t (0.6%); and finally tugboats, 1.87 t (4.0%).

**4.4.2 Ship sewage**

Fifty ships were sampled in the survey on sewage discharged from registered ships in the project area this year. Forty-one out of them disposed sewage before discharging it into the environment. Up to 82.93% of the said 41 ships attained discharge standard for suspended solids, 90.24% for biochemical oxygen demand ($BOD_5$), 80.49% for COD, 51.22% for total nitrogen (TN), and 75.61% for E.coli. Only one ship attained discharge standard for TP. Nine ships dumped sewage directly into the environment without any disposal, and so none of their monitoring items attained discharge standards.

It was estimated that the ships in the project area discharged about 3,971,000 t of sewage, up 82,000 t from a year earlier. The estimate was based on the ship population in the project area, sewage discharge amount, passenger load, crew size, shipping hours, and percentage of ships with different tonnages. Among others, passenger boats discharged 2,803,000 t of sewage, accounting for 70.6% of the total; freight boats 806,000 t (20.3%); non-transport boats 342,000 t (8.6%); and tugboats 20,000 t (0.5%).

The pollutant load in descending order in the sewage water was COD (711.2 t), suspended solids (705.2 t), TN (336.0 t), $BOD_5$ (297.1 t), and TP (50.7 t).

**4.4.3 Ship garbage**

Forty-one ships were sampled in the survey on garbage generated by and collected from the ships in the project area in 2012. Based on the survey, the garbage generated by the ships registered in the project area was estimated to be around 52,000 t. Among others, 7,415.7 t was collected by maritime authorities from ships, accounting 14.3% of the total.

# Chapter 5
# Water Environment Quality

The monitoring items of the water environment quality in the Three Gorges Project area in 2012 included the streamflow and water quality of the mainstream and tributaries of Yangtze River, and the comprehensive trophic state and algal bloom outbreak of main tributaries. The evaluation of overall water quality and trophic state shall comply with *Measures on the Evaluation of Environment Quality of Surface Water (on trial) (MEP GO [2011]22).*

## 5.1 Streamflow

There were five sections monitored in 2012 for the streamflow of the mainstream of the Yangtze River in the project area, which were, Zhutuo Section in Yongchuan District, Cuntan Section in Chongqing city proper, Qingxichang Section in Fuling District, Tuokou Section in Wanzhou District, and Guandukou Section in Badong County. The discharge of the mainstream in the project area ranged between 2,660 $m^3/s$ and 47,100 $m^3/s$, and the mean flow rate ranged between 0.07 m/s and 2.82 m/s. Affected by the impoundment of the Reservoir, the flow rate of the reach between Tuokou Section and the Dam was much lower than that of the upstream reaches of the mainstream. The mean flow rate registered 1.56 m/s (Zhutuo), 1.42 m/s (Cuntan), 0.77 m/s (Qingxichang), 0.39 m/s (Tuokou), and 0.27 m/s (Guandukou) respectively. The maximum flow rate was 2.53 m/s (Zhutuo), 2.82 m/s (Cuntan), 2.27 m/s (Qingxichang), 1.17 m/s (Tuokou), and 0.67 m/s (Guandukou) respectively.

## 5.2 Water quality

There were six sections monitored for water quality of the mainstream of Yangtze River in the project area this year, i.e., Zhutuo Section in Yongchuan District, Cuntan Section in Chongqing city proper, Jiangjin Bridge Section, Qingxichang Section in Fuling District, Shaiwangba Section in Wanzhou District, and Nanjinguan Section in Yichang City. Moreover, there were two sections monitored for the water quality of the tributary Jialing River, i.e., Jinzi Section and Beiwenquan Section, and two sections monitored for the water quality of the tributary Wujiang River, i.e., Wanmu Section and Luoying Section. What's more, there were 77 sections monitored for the trophic state of 38 main tributaries affected by backwater effect of the mainstream, and of bay waters in the upstream of the Dam, which has similar hydrological conditions with those tributaries.

The monitoring data indicated the mainstream of Yangtze River running through the project area enjoyed good water quality, Jialing River recorded excellent water quality, but excess TP was observed in Wujiang River.

Nanjinguan Section in the mainstream of Yangtze River attained Grade II standard for overall water

Table 5–1 Water quality of monitoring sections in the mainstream of Yangtze River in the Three Gorges Project area in 2012

| Section | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sept. | 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 | II | II | II | III | III | III | III |
| Cuntan | III | III | II | III | II | III | III | III | III | III | III | III | III |
| Qingxichang | III | III | III | III | III | III | III | III | III | III | III | III | III |
| Shaiwangba | III | III | III | IV | IV | III | III | III | III | III | III | III | III |
| Nanjinguan | II | II | II | II | II | II | II | II | II | II | II | II | II |

quality and for *E.coli* this year, while the remaining five sections attained Grade III standard for overall water quality and for *E.coli*. Monthly data showed Zhutuo, Jiangjin Bridge, Cuntan, Qingxichang, and Nanjinguan sections attained Grade III or better water quality standard for 12 months. Shaiwangba Section attained Grade IV water quality standard in April and May, and Grade III standard in the rest of the months; the main pollutant was TP. Nanjinguan Section attained Grade II standard for *E.coli* for 12 months, and the remaining five sections attained Grade III standard for *E.coli* throughout the year.

Jinzi Section and Beiwenquan Section of Jialing River attained Grade II water quality standard this year. Wanmu Section and Luoying Section of Wujiang River recorded water quality which failed Grade V national standard; the main pollutant was TP. According to monthly data, Jinzi Section and Beiwenquan Section attained Grade III national standard across the year; Wanmu Section observed water quality failing Grade V national standards for 12 months; Yingluo Section attained Grade V water quality standards in January, September, and December; Grade IV standard in October and November; and failed Grade V standard during other months.

Table 5–2 Water quality of monitoring sections of Jialing River and Wujiang River in the Three Gorges Project area in 2012

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

## 5.3 Trophic state and algal blooms of tributaries

### 5.3.1 Trophic state

Five indicators including chlorophyll a, TP, TN, $COD_{Mn}$, and SD were employed to computer the trophic level index (TLI) and evaluate comprehensive trophic state of tributary waters. The monitoring data showed that the trophic state of 38 main tributaries in the project area was improved compared with last year during the algal bloom sensitive period from March to October.

Monthly data indicated 7.8%~37.7% of the 77 monitoring sections were in eutrophic state, 58.4%~85.7% in mesotrophic state, and 1.3%~10.4% in oligotrophic state. Among others, 5.0%~52.5% of the sections in backwater reaches were in eutrophic state, so were 10.8%~24.3% of the sections in non-backwater reaches. Eutrophic level was higher in backwater reaches than in non-backwater reaches. The year-on-year percentage of eutrophic sections in backwater reaches was down 27.5 percentage points in March, 17.5 percentage points in May, 10.0 percentage points in July, and 15.0 percentage points in October; and up 7.5 percentage points in April, 2.5 percentage points in June, 5.0 percentage points in August, and 5.0 percentage points in September.

### 5.3.2 Algal blooms

The algal bloom outbreaks in the main tributaries of Yangtze River in the project area were stable compared with last year. Algal blooms were observed in backwater reaches of the main tributary rivers, including Rangdu River, Baolong River, Xiangxi River, Chixi River, Tongzhuang River, Caotang River, Meixi River, Yulin River, Zhuxi River, Longxi River, Pengxi River, Daning River, Shennong Stream, Ruxi River, Longhe River, Huangjin River, Dongxi River, Zhenxi River, Lixiang Stream, Qinggan River, Quxi River, and Chixi River. The dominant algae species were Cyclotella species of Bacillariophyta, Peridinaceae species of Pyrrophyta, Chlamydomonas species of Chlorophyta, Aphanizomenon and Microcystis species of Cyanophyta, and Cryptomonas species of Cryptophyta. Algal bloom outbreaks mostly occurred in the spring and autumn,

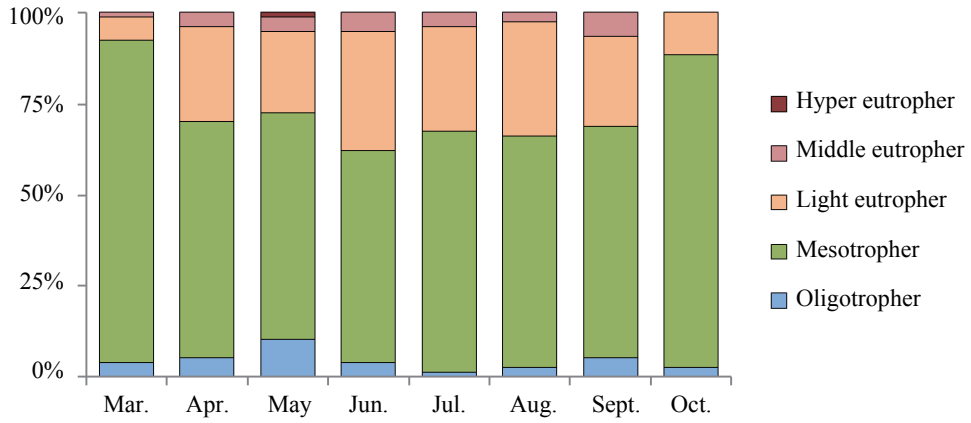



Figure 5–1 Trophic level of main tributary rivers of Yangtze River in the Three Gorges Project area between March and October 2012

exhibiting evident seasonal changes. The dominant algae species were Cyclotella, Cryptomonas and Peridinaceae species in the spring, Cyclotella and Microcystis species in the summer, and Cryptomonas and Microcystis species in the autumn.

# Chapter 6
# Public Health

## 6.1 Background

The public health monitoring program for the project area this year covered 19 townships, towns, and sub-districts distributed in five monitoring sites, i.e., the city proper, Fengdu County, Wanzhou District, and Fengjie County of Chongqing Municipality, as well as Yichang City of Hubei Province. A total of 739,010 local residents were monitored throughout the year, up 9,922 ones from a year earlier. Among them, 378,238 were male and 360,772 female, with gender ratio at 1.05:1; 405,059 were urban residents and 333,951 rural residents. There were 309 medical institutions at all levels in the monitoring sites, up by 1 compared with last year. There were a total of 4,678 hospital beds in these institutions, up 170 from a year earlier. Altogether 5,182 medical staff worked in these institutions, down 147 compared with last year, which was mainly attributed to replacement of monitored towns and townships and restructuring of local medical institutions.

## 6.2 Life statistics

### 6.2.1 Birth and death

A total of 6,291 babies were born this year in the monitoring sites-Chongqing city proper, Fengdu, Wanzhou, and Fengjie, and Yichang, 3,317 of them were male and 2,974 female, with gender ratio at 1.12:1. The birth rate registered 8.51‰, up 12.72% compared with last year. A total of 4,186 people deceased this year, with mortality of 5.66‰, down 1.05% compared with last year; male death rate was 6.72‰ and female 4.56‰.

The birth rate of the monitoring site of Chongqing city proper, Fengdu, Wanzhou, Fengjie and Yichang was 8.15‰, 9.97‰, 5.54‰, 12.24‰ and 8.91‰, and death rate 5.70‰, 6.88‰, 5.06‰, 4.94‰ and 6.37‰ respectively. Compared with the previous year, the birth rate of Yichang, Fengjie, Wanzhou, Chongqing city proper, and Fengdu was up 52.57%, 14.29%, 13.99%, 3.30% and 1.01% respectively; while the death rate of Fengdu was up 7.17%, and that of Yichang, Fengjie, Wanzhou, and Chongqing city proper was down 15.18%, 1.40%, 0.59% and 0.18% respectively.

There were 33 reported infant deaths throughout the monitoring sites, 24 male and 9 female. The infant death rate registered 5.25‰, down 32.86% from the previous year.

### 6.2.2 Analysis of death cause

According to the ICD-10 disease classification standard, the top five death causes of the local residents in the monitoring sites in 2012 were circulatory system diseases, malignant tumors, respiratory system diseases, injury and poisoning, and digestive system diseases, with mortality at 183.08/100,000, 153.04/100,000, 101.62/100,000, 38.16/100,000 and 21.11/100,000 respectively. The percentage of deaths claimed by the top five diseases against the total deaths was 32.32%, 27.02%, 17.94%, 6.74% and 3.73% respectively, totaling 87.74%.

The ranking of the top five killer diseases remained unchanged, and there was little variation in death cause structure compared with the previous year. Among others, mortality of respiratory and digestive system diseases went up 16.99% and 23.97%, and that of circulatory system diseases, malignant tumors, and injury and poisoning went down 6.61%, 3.33% and 25.45% respectively. Gender analysis showed that the ranking of the top five death causes for females was consistent with that of the general population, while the top death cause of male was malignant tumor, followed by circulatory system diseases, and then as the ranking of general population, followed by respiratory system diseases, injury and poisoning, and digestive system diseases. The mortality of the top five killer diseases was higher among male patients compared with female patients. Region-specific analysis showed that the ranking of death causes varied from region to region. The top killer disease was circulatory system diseases in Fengdu and Yichang, the same as the general population; but malignant tumors in Chongqing city proper, Wanzhou, and Fengjie.

## 6.3 Monitoring of diseases

### 6.3.1 Monitoring of infectious diseases

A total of 3,434 cases of notifiable infectious diseases were reported throughout the monitoring sites this year with morbidity at 464.68/100,000, up 3.34% compared with last year. There was neither reported death due to infectious diseases nor report of any case of Category A infectious diseases. The morbidity in descending order in the monitoring sites was 668.48/100,000 in Yichang, 593.97/100,000 in Chongqing city proper, 408.13/100,000 in Fengdu, 408.13/100,000 in Wanzhou, and 286.29/100,000 in Fengjie. The morbidity was up 24.74%, 18.42% and 18.64% respectively in the monitoring site of Fengdu, Wanzhou, and Yichang, and down 20.41% and 15.11% respectively in the monitoring site of Chongqing city proper and Fengjie from the previous year. There was report of infectious diseases in all monitoring sites every month but no report on epidemic outbreak. Among others, the reported cases of Category B infectious diseases peaked in March and April (above 200 cases) and hit the bottom in December. There were two peaks (from May to June and from October to December) of reported cases of Category C infectious diseases, which were mainly hand-foot-and-mouth disease, parotitis and other types of infectious diarrhea.

The monitoring sites reported 1,984 cases of diseases which fell into 13 types of Category B infectious diseases (excluding HIV), with morbidity at 268.47/100,000, down 0.99% compared with last year. The morbidity of Category B infectious diseases peaked at 558.38/100,000 in Yichang monitoring site and hit the bottom at 177.90/100,000 in Wanzhou monitoring site. The morbidity was up 44.07%, 18.53% and 2.17% respectively in Wanzhou, Yichang, and Fengdu monitoring sites, and down 31.19% and 18.66% in Chongqing and Fengjie monitoring sites. The top five Category B infectious diseases measured by morbidity were viral hepatitis (112.99/100,000), tuberculosis (112.72/100,000), syphilis (18.4/100,000), dysentery (16.78/100,000), and gonorrhea (3.38/100,000). Those five diseases accounted for 98.44% of the total cases of Category B infectious diseases. Leptospirosis and malaria were novel types of Category B infectious disease reported in the monitoring sites and there was no report of epidemic cerebrospinal meningitis or hemorrhagic fever compared with the previous year. The morbidity of hepatitis B, hepatitis C, non-branched type hepatitis, AIDs, Japanese encephalitis, and tuberculosis was up and that of other Category B infectious diseases was down. The HIV-infected population was down 5.58% from a year earlier. The morbidity of water-borne infectious diseases hepatitis A (2.17/100,000), dysentery (16.78/100,000) and typhoid (0.14/100,000) which were relevant to the Reservoir impoundment was still at a low level. There were reported cases of natural focus diseases related to change of media insects, including Japanese encephalitis (two cases), leptospirosis (one case), and malaria (one case). But, there was no report of dengue fever or hemorrhagic fever.

A total of 1,450 cases of diseases which fell into 7 types of Category C infectious diseases were reported in the monitoring sites, with morbidity at 196.21/100,000, a year-on-year increase of 10.04%. The morbidity of Category C infectious diseases in the monitoring site of Chongqing city proper, Wanzhou, Fengdu, Yichang and Fengjie was 282.84/100,000, 230.23/100,000, 198.49/100,000, 110.1/100,000 and 96.92/100,000 respectively. The morbidity in Fengdu, Yichang, and Wanzhou went up 72.66%, 19.19% and 4.10% respectively, while that of Chongqing city proper and Fengjie went down 3.84% and 7.22% respectively compared with last year.

### 6.3.2 Monitoring of endemic diseases

Iodine Deficiency Disorders (IDD) was monitored in the monitoring sites of Chongqing city proper, Wanzhou, Fengdu, Yichang and Fengjie in 2012. Palpation method was employed to diagnose IDD for 731 sampled children aged between 8 and 12. Twenty-four children were diagnosed with Degree-I thyromegaly, accounting for 3.28%, and with mild decline compared with 2011; it was a small-scale epidemic. Thyromegaly morbidity in Fengdu, Wanzhou, and Yichang recorded 7.50%, 4.65% and 0. 25% respectively. A total of 1,130 households were sampled for the test of edible salt, and data showed that 1,127 families took iodine added salt, taking up 99.73%, and down 0.19 percentage point from a year earlier. The iodine added salt in 1,102 households was found qualified, taking up 98.78%, and down 0.62 percentage point from a year earlier. The consumption rate of qualified iodine-added salt was 97.52%, down 0.80 percentage point. The coverage, qualification rate of iodine-added salt, and consumption rate of qualified iodine-added salt kept at fairly high levels.

Dental fluorosis was monitored this year in Fengjie County with 109 sampled children aged between 8 and 12. Forty-one cases of such disease were diagnosed,

so the positive rate was 37.61%, up 1.46% from a year earlier.

## 6.4 Monitoring of biological media

### 6.4.1 Monitoring of rats

The mean density of indoor rats was 2.54% and of outdoor rats was 2.49% in the monitoring sites this year, both higher than that of the previous year and lower than the 5-year (1999-2003, sic passim) average (indoor 3.94%, outdoor 4.22%) before the impoundment in 2003. The mean density of indoor rats in the spring was close to that in the autumn, and the mean density of outdoor rats was higher in the spring than in the autumn. The mean density of indoor rats (2.54%) was lower than that of outdoor rats (2.61%) in the spring, as opposed to last year; and mean density of indoor rats (2.55%) was higher than that of outdoor rats (2.38%) in the autumn, the same as last year. The mean density of indoor rats in descending order this year was 6.07% in Fengdu, 2.52% in Fengjie, 2.38% in Wanzhou, 1.79% in Chongqing city proper, and 0.52% in Yichang. The mean density of outdoor rats in descending order this year was 6.45% in Fengdu, 2.74% in Wanzhou, 1.30% in Yichang, 1.08% in Fengjie, and 0.81% in Chongqing city proper. The 16-year monitoring data indicated the mean density of either indoor or outdoor rats was on the decline in the monitoring sites.

*Rattus norvegicus* was the dominant indoor rat species in the year, taking up 44.44%, followed by *Rattus flavipectus* (28.89%), and then *Mus musculus* (23.33%). In the field, the small insectivore (mostly *Anourosorex squamipes*) remained the dominant species, accounting for 40.91%; followed by *Rattus norvegicus* (29.55%); *Apodemus agrarius* was the last but one species, accounted for 3.03% and down 1.09 percentage points compared with last year. As the host of Hantavirus and leptospira virus, *Apodemus agrarius* has been ranking the 2$^{nd}$ or the 3$^{rd}$ dominant outdoor rat species for years, but its percentage decreased significantly in 2011 and 2012, due to unknown reasons.

### 6.4.2 Monitoring of mosquitoes

The gross density of adult mosquitoes in livestock pens and human dwellings was 132.31/pen•labor hour and 17.66/room•labor hour respectively this year, both figures lower than that of last year and the 5-year average (198.57/pen•labor hour for the former and 63.97/ room•labor hour for the latter) before the phase-II impoundment. Indoor adult mosquito density in descending order at the monitoring sites was Chongqing city proper (40.70/room•labor hour), Wanzhou (36.88/room•labor hour), Fengdu (12.68/room•labor hour), Fengjie (8.24/room•labor hour), and Yichang (4.04/room•labor hour). The adult mosquito density in livestock pens in descending order was Wanzhou (344.48/pen•labor hour), Fengdu (189.84/pen•labor hour), Chongqing city proper (125.37/pen•labor hour), Yichang (95.36/pen•labor hour), and Fengjie (57.51/pen•labor hour). The adult mosquito density in human dwellings went up in Chongqing city proper, Fengdu, and Yichang, and down in Wanzhou and Fengjie compared with last year. The adult mosquito density in livestock pens rose in Fengdu but declined in other monitoring sites compared with 2011. The 16-year monitoring data indicated the indoor adult mosquito density decreased year by year, while the adult mosquito density in livestock pens had been on the decline for the first 10 years and remained stable in recent six years.

The 10-day variations of indoor adult mosquito density from May to September were similar to that of the adult mosquito density in livestock pens. Yichang monitoring site was the first to observe the peak of indoor adult mosquito density within first 10 days of June, and Wanzhou was the last within the last 10 days of August; Chongqing city proper and Fengdu observed the peak density within the last 10 days of July and Fengjie within the last 10 days of June. As for adult mosquito density in livestock pens, the peak came the first in Yichang in the first 10 days of June and the last in Wanzhou in the last 10 days of August; the rest of the monitoring sites observed the peak in either the first or the last 10 days of July. The mosquito species analysis showed that *Armigeres subalbatus* was the dominant mosquito species in both human dwellings and livestock pens, accounting for 72.53% and 81.75% of the total. *Culex pipiens fatigans* was the secondary dominant indoor mosquito species (18.02%), followed by *Culex pipiens pallens, Culex tritaeniorhynchus*, and *Anopheles sinensis*. Among the mosquito species in livestock pens, *Culex pipiens fatigans* was the secondary dominant, followed by *Culex tritaeniorhynchus, Anopheles sinensis*, and *Culex pipiens pallens*. The percentage of *Armigeres subalbatus* and *Culex pipiens fatigans* went up in both human dwellings and livestock pens compared with last year, and the share of other mosquito species went down.

# Chapter 7
# Environmental Quality of the Dam Area

## 7.1 Streamflow and meteorology

### 7.1.1 Streamflow

The statistics on the monitoring data at Huanglingmiao Streamflow Measuring Station in the downstream of the Three Gorges project showed the mean annual discharge registered 14,700 $m^3/s$ this year, with maximum discharge at 46,100 $m^3/s$ on July 30 and minimum discharge at 5,670 $m^3/s$ on December 4. The mean annual sediment discharge rate was 1.43 t/s, and mean sediment concentration 0.097 $kg/m^3$. The mean sediment concentration peaked at 0.607 $kg/m^3$ on July 7, and hit the bottom at 0.001 $kg/m^3$ on January 1. The mean annual discharge, mean annual water level, mean annual sediment discharge rate, and mean sediment concentration increased to some extent from a year earlier in the Three Gorges Dam area.

Table 7–1 Monthly discharge at Huanglingmiao Streamflow Measuring Station in 2012

Unit: $m^3/s$

| Month | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 6480 | 6500 | 6460 | 6900 | 16200 | 17400 | 39000 | 26500 | 20200 | 14800 | 8660 | 6290 | 14700 |
| Max. | 7940 | 7430 | 7100 | 8760 | 26700 | 29200 | 46100 | 42300 | 28200 | 21600 | 13200 | 8540 | 46100 |
| Min. | 5780 | 5840 | 5710 | 5710 | 5940 | 12500 | 20700 | 13200 | 12600 | 8640 | 5800 | 5670 | 5670 |

Table 7–2 Monthly sediment concentration at Huanglingmiao Streamflow Measuring Station in 2012

Unit: $kg/m^3$

| Month | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 0.002 | 0.002 | 0.003 | 0.003 | 0.004 | 0.012 | 0.287 | 0.151 | 0.061 | 0.008 | 0.004 | 0.003 | 0.097 |
| Max. | 0.003 | 0.003 | 0.003 | 0.004 | 0.009 | 0.019 | 0.607 | 0.358 | 0.130 | 0.014 | 0.006 | 0.003 | 0.607 |
| Min. | 0.001 | 0.002 | 0.003 | 0.002 | 0.002 | 0.007 | 0.017 | 0.023 | 0.009 | 0.005 | 0.003 | 0.003 | 0.001 |

### 7.1.2 Climate

The mean annual temperature (MAT) and mean annual precipitation (MAP) were on the low side compared with historical average in the Three Gorges Dam area this year.

**● Precipitation**

The MAP of the Dam area was 834.7 mm, down 18.3% from the historical average. The precipitation distributed extremely uneven among 12 months, as the rain fell mainly from May through October, with maximum daily precipitation at 55.7 mm on May 29. The longest rain spell within the year lasted 22 days between July 11 and August 1, whereas the longest dry spell within the year was up to 13 days from August 7 through 19.

**● Temperature**

The MAT of the Dam area registered 16.2℃, down 0.9℃ from the historical average. The extreme maximum temperature within the year reached 37.5℃ on June 19

and July 9, while the extreme minimum temperature was -1.8℃ recorded on December 24.

● **Wind speed**

The mean annual wind speed of the Dam area was 1.1 m/s with the maximum at 14.0 m/s observed on August 6. Wind direction was ever-changing throughout the year with North as the dominant direction, taking up 10%.

Table 7–3 Meteorological elements of the Three Gorges Dam area in 2012

| Month | | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp | T(℃) | 4.9 | 5.7 | 10.3 | 17.2 | 21.0 | 25.3 | 27.4 | 26.6 | 22.1 | 16.9 | 11.4 | 5.6 | 16.2 |
| | Departure (℃) | -0.1 | -1.9 | -1.6 | -0.4 | -0.8 | -0.1 | 0.1 | 0.0 | -0.8 | -1.0 | -1.5 | -1.9 | -0.9 |
| Precipitation | P (mm) | 13.0 | 3.8 | 42.1 | 53.6 | 129.3 | 43.7 | 173.5 | 79.5 | 113.7 | 126.8 | 32.0 | 23.7 | 834.7 |
| | Departure (%) | -25.7 | -90.3 | -15.5 | -38.0 | 6.2 | -62.8 | 0.9 | -54.4 | 3.4 | 74.7 | -29.8 | 49.7 | -18.3 |
| wind speed | Mean (m/s) | 1.5 | 1.2 | 1.2 | 0.7 | 0.7 | 0.8 | 0.7 | 0.8 | 0.7 | 0.5 | 0.8 | 1.2 | 1.1 |
| | Max.(m/s) | 4.9 | 5.3 | 6.3 | 6.3 | 4.4 | 8.4 | 7.5 | 8.6 | 4.8 | 4.2 | 5.1 | 5.2 | 11.2 |
| | Extreme (m/s) | 8.8 | 10.4 | 11.0 | 11.3 | 7.1 | 13.3 | 10.6 | 14.0 | 10.7 | 7.6 | 9.7 | 10.3 | 20.6 |

## 7.2 Air quality

Assessment of ambient air quality of the Three Gorges Dam area (office and residential areas, and construction sites) shall comply with the *Ambient Air Quality Standard (GB3095-1996)*.

The mean annual $SO_2$ concentration in the Dam area was 0.006 mg/m$^3$, attaining Grade I standard specified in the *Ambient Air Quality Standard (GB3095-1996)*, the same as last year; the mean daily $SO_2$ concentration also attained Grade I standard. The mean annual $NO_2$ concentration was 0.016 mg/m$^3$, attaining Grade I standard as well but going down 0.003 mg/m$^3$ compared with last year. The mean daily $NO_2$ concentration also attained Grade I standard.

The mean annual TSP concentration was 0.145 mg/m$^3$, attaining Grade II standard and down 0.005 mg/m$^3$ from a year earlier. In office and residential areas, the mean daily TSP concentration attained Grade I standard during 45.8% of the days throughout the year, Grade II standard during 53.5% of those days, and Grade III standard during 0.7% of those days. In the construction sites, the mean daily TSP concentration attained Grade I standard during 42.4% of the days throughout the year, Grade II standard during 56.2% of those days, and Grade III standard during 1.4% of those days.

The mean annual $NO_2$ concentration was down 15.8%, mean annual TSP concentration down 3.3%, and mean annual $SO_2$ concentration was the same as last year in the construction sites. In general, the ambient air quality of the Dam area saw continuous improvement.

## 7.3 Water quality

A total of 13 indicators including pH value, dissolved oxygen, ammonia nitrogen, COD, $COD_{Mn}$, $BOD_5$, volatile phenol, cyanide, arsenic, $Cr^{6+}$, copper, lead, and cadmium were selected for the assessment of water quality in the mainstream of Yangtze River in the Dam area, in accordance with *Environmental Quality Standard for Surface Water (GB3838-2002)*. Apart from the above 13 indicators, anion surfactant indicator was also applied to evaluate near-bank water quality.

The monitoring sections of the Yangtze River mainstream and near-bank waters in the Dam area enjoyed excellent water quality throughout the year and attained Grade I standard for surface water quality. Taipingxi Section and Letianxi Section of the mainstream attained Grade I water quality standard as opposed to Grade II standard last year. The same case went to the three monitoring sites at near-bank waters, i.e., upstream approach channel, downstream approach channel, and auxiliary dam.

Table 7–4 Water quality in the mainstream sections of Yangtze River in the Three Gorges Dam area in 2012

| Section | 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter | Year |
|---|---|---|---|---|---|
| Taipingxi | I | I | II | I | I |
| Letianxi | I | I | II | I | I |

Table 7–5 Water quality in near–bank waters of Yangtze River in the Three Gorges Dam area in 2012

| Sampling site | | 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter | Year |
|---|---|---|---|---|---|---|
| Left bank (30m to the bank) | Upstream approach channel | I | I | II | I | I |
| | Downstream approach channel | I | I | II | I | I |
| Right bank (30m to the bank) | Auxiliary dam | I | II | II | I | I |

## 7.4 Noise

In the office and residential areas of the Dam area, the daytime/nighttime ambient noise level averaged at 55.9 dB/46.7 dB in 2012, attaining Grade II standard in *Environmental quality standard for noise (GB3096-2008)*. The mean ambient noise level was down 1.1 dB at day and up 1.2 dB at night compared with last year. In the construction sites, the mean ambient noise level was 55.4 dB in the day and 49.3 dB at night, both within the noise limits for workshops and operation sites specified in *Specifications for the Design of Noise Control System in Industrial Enterprises (GBJ87-85)*; and up 2.9 dB and 1.6 dB respectively compared with last year. The noise level in the boundaries of the construction sites was within the noise limits set by the *Emission standard of environment noise for boundary of construction site (GB12523-2011)*. The mean annual traffic noise level of the Dam area recorded 66.7 dB, down 2.3 dB compared with last year.

# Chapter 8
# Monitoring and Studies on Regional 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**

The compound ridge tillage of grain crops, cash crops and fruit trees on slope farmland (hereinafter referred to as Model I) helps retain soil moisture, lower soil bulk density, increase soil porosity and percentage of silt loam, improve soil nutrients, substantially reduce soil erosion and surface runoff, and cut down the nitrogen and phosphorus contents in the surface runoff. The soil moisture of Model I is higher than that of compound flat tillage of grain crops, cash crops and fruit trees on slope farmland (hereinafter referred to as Model II), and the flat tillage of grain crops up and down the slope (hereinafter referred to as Model III). The soil moisture varied little with the soil depth variations.

The monitoring data of the year showed the soil moisture of Model I was 10.70% higher than that of Model III in 2 days after rain, 13.19% higher in 4 days after rain, and 15.51% higher in 8 days after rain; the mean soil moisture in the furrow after rain was 2.57% higher than that on the ridge. The soil moisture of Model I was 7.53% higher than Model II in 2 days after rain, 10.26% higher in 4 days after rain, and 12.24% higher in 8 days after rain. As for soil nutrients, the contents of soil nutrients of Model I were higher than that of Model III; among others, organic matters were 9.90% higher, TN 12.28%, TP 17.64%, total potassium (TK) 15.42%, Kjeldahl nitrogen 17.02%, available phosphorus (AP) 11.53%, and available potassium (AK) 9.48% higher. Compared with the previous year, the organic matters of Model I was down 11.63%, TN 6.25%, TP 3.33%, Kjeldahl nitrogen 4.17%, AP 4.72%, and AK 8.76%, except TK was up 5.47%.

*Watershed soil survey*

Model I helps reduce soil erosion and surface runoff. Compared with Model III, the soil erosion of Model I was down 0.0532 t/ha., and surface runoff down 51.69 $m^3$/ha.. Among the three models, the nutrients in the sediments (except TP, TK, and AP) were the highest in Model I, followed by Model II and then Model III. The soil erosion in Model I was down 19.80% and surface runoff down 46.80% compared with last year, while the content of organic matters in the eroded soils was up 4.67%, of TK 0.89%, of AP 3.60%, and of AK 1.73%; the content of TN was down 14.27%, of TP 0.66%, and of Kjeldahl nitrogen 1.14%. The content of either TN or TP in the surface runoff of Model I was lower than other two models but increased to some extent from a year earlier.

**8.1.2 Experiment on steep slope with hedgerow**

The steep slope with *Citrus grandis-Hemerocallis citrina* hedgerow model (hereinafter referred to as the hedgerow model) created substantial benefits of water and soil conservation. The experiment on the hedgerow model this year showed the mean soil moisture of hedgerow model was 0.50% higher in 2 days after rain, 0.21% higher in 4 days after rain, and 1.71% higher in 8 days after rain than Model III. The hedgerow helps stabilize the variations of soil moisture of slope farmlands. Analysis of the spatial distribution of soil moisture revealed maximum soil moisture was recorded in the hedgerow, and the moisture in the lower layer soils was higher than in the upper layer soils. The soil porosity of the hedgerow registered 49.67%, a little higher than that of Model III. The hedgerow helps substantially enrich the organic matters in soils, the content of which was 16.28% higher compared with Model III, and up

*Investigations in rural households*

10.19% from a year earlier. The TN content of hedgerow model was 24.43% higher compared with Model III, and up 4.27% from a year earlier; the content of Kjeldahl nitrogen was 27.13% higher than Model III, and down 6.46% from a year earlier; the content of TP and AP was 9.87% and 13.82% higher than Model III, and up 19.31% and 4.15% from a year earlier; the content of TK and AK was 4.16% and 35.14% higher than Model III, and down 2.43% and 2.03% respectively compared with the previous year.

As for reduced water and soil loss of slope land, the hedgerow model cut down the surface runoff by 8.14 $m^3$/ha., reduced the soil erosion by 0.0612 t/ha., and increased the content of organic matters, TN, TP, TK, Kjeldahl nitrogen, AP, and AK in the sediments by 41.21%, 43.94%, 32.17%, 17.48%, 91.91%, 24.74% and 66.38% respectively compared with Model III. The nutrients in the eroded sediments of the hedgerow model increased from a year earlier by 25.75% for TN, 14.87% for TP, 13.75% for TK, 17.46% for Kjeldahl nitrogen, 8.79% for AP, and 31.33% for AK, and down 22.01% for organic matters. The TN and TP contents of the surface runoff of hedgerow model were lower than that of Model III.

## 8.2 Zigui Model Zone

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

Ecological conservation measures help substantially control soil erosion, and water and nutrient loss of steep slope farmlands. There are three ecological models-*Lolium perenne-Glycine max* plot with interplanted *Toona sinensis* as the hedgerow, *Triticum aestivum-Arachis hypogaea* plot with interplanted *Toona sinensis* as the hedgerow, and *Triticum aestivum-Arachis hypogaea* plot with interplanted *Medicago sativa* as the hedgerow. Compared with conventional Triticum aestivum-Arachis hypogaea plot, the slope runoff of the three ecological models dropped by 19.6%, 35.4% and 31.6% respectively; the slope erosion was reduced by 38.9%, 65.3% and 63.2%; total loss of nitrogen went down 32.8%, 18.5% and 49.2%; and the total loss of phosphorus dropped by 33.4%, 52.1% and 54.6%.

As opposed to conventional navel orange orchard, there are three ecological models, i.e., navel orange orchard interplanted with perennial *Trifolium repens*, navel orange orchard with stalk coverage on the ground, and navel orange orchard with intercropped *Hemerocallis citrina* as hedgerow. Compared with conventional navel orange orchard, the slope runoff of the three ecological models dropped by 4.6%, 3.5% and 21.2%; and sediment yield was down 32.0%, 26.2% and 46.6%. Moreover, the runoff of another model-the slope embedded with impermeable membrane, went up 21.2%, but the sediment yield dropped by 12.6%. All in all, the nitrogen loss of the aforementioned four models was down 33.0%, 41.4%, 73.4% and 44.5%, and phosphorus loss down 54.6%, 49.4%, 75.9% and 59.7% respectively compared with the conventional navel orange plots.

**8.2.2 Studies and demonstrationon eco-agricultural models on the slope farmland**

The land use and management patterns have significant impact on the soil fertility in mountainous area. In the semi-alpine regions with altitude above 700 m and dominated by traditional agriculture, the mean content of organic matters, TN, TP, and TK was 16.02 g/kg, 1.26 g/kg, 0.45 g/kg, and 17.64 g/kg this year; and that of Kjeldahl nitrogen, AP, and AK recorded 111.73 mg/kg, 26.25 mg/kg, and 131.66 mg/kg. In the citrus distribution zone below EL.700 m, the mean content of organic matters, TN, TP, and TK registered 13.76 g/kg, 1.27 g/kg, 0.59 g/kg, and 18.23 g/kg, and that of Kjeldahl nitrogen, AP, and AK recorded 102.99 mg/kg, 47.25 mg/kg, and 231.11 mg/kg. The monitoring data indicated relatively low content of organic matters in soils of the citrus plantations in the low-altitude zone, where the content of TN, TP, TK, AP, and AK was a little higher than that of traditional agricultural plantations in the semi-alpine region. This might be attributed to the fact that more chemical fertilizers and less organic fertilizers were applied in the low-altitude regions. Another factor causing variations in the content of organic matters at different altitudes was the vertical

climate diversity in mountainous regions. Compared with last year, the content of organic matters in soils of citrus plantations in the low-altitude region went down, while the TN, TP, TK, AN, AP, and AK content went up; no obvious variations were observed in the organic matters and nitrogen, phosphorus and potassium content in the moderate-and high-altitude regions above 700 m.

A 12-year long-term experiment proved protective management measures may increase the content of organic matters in soils and improve the supply of nutrients. Under conventional management model, the content of organic matters, TN, TP, and TK of navel orange orchard amounted to 5.58 g/kg, 1.53 g/kg, 0.36 g/kg, and 15.69 g/kg respectively this year. Compared with conventional orchard, the content of organic matters went up by over 41.6% and of TP up by over 39.0% in three ecological models, i.e., navel orange orchard interplanted with perennial *Trifolium repens*, navel orange orchard with stalk coverage on the ground, and navel orange orchard with intercropped *Hemerocallis citrina* as hedgerow. The TN content in the model of navel orange orchard interplanted with perennial *Trifolium repens*, and of navel orange orchard with intercropped *Hemerocallis citrina* as hedgerow rose by over 12.8%. The content of organic matters, TN, TP, and TK in *Triticum aestivum-Arachis hypogaea* plots under conventional management registered 7.90 g/kg, 0.91 g/kg, 0.55 g/kg, and 19.91 g/kg this year. The content of organic matters and TN in soils of *Triticum aestivum-Arachis hypogaea* plot with interplanted *Medicago sativa* as the hedgerow went up 20.2% and 4.2% respectively compared with conventional model.

The integrated water and fertilizer management technology applied in the citrus orchard helps raise the citrus yield per unit area, shorten labor hours, raise social and economic benefits, and substantially improve the nutrient efficiency. The water and fertilizer integrated moistube sub-surface irrigation technology applied in the project area helped increase the yields of citrus by 30% this year.

## 8.3 Water-level-fluctuating zone

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

### 8.3.1 Soil physical and chemical properties

The monitoring data on soil particle composition of the water-level-fluctuating zone this year showed the project area has fine soil texture and there are a high percentage of particles with diameter below 0.05 mm.

The monitoring data on content of heavy metals in soils indicated the content of arsenic, cadmium, lead, zinc, iron, and manganese dropped by 30.06%, 19.23%, 0.21%, 2.58%, 15.03% and 9.09% respectively from a year earlier after the water subsided, while the content of mercury, chromium, and copper was up 44.44%, 19.76% and 10.73%. The content of most heavy metals lowered down before the impoundment compared with the situation after waters subsided months ago. The content of most heavy metals (except lead and copper) in soils was within the limits set by Grade I national standard for soil environment quality.

The monitoring data on soil nutrients showed 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 waters subsided in June, the content of organic matters, TP, TK, AP, AK, and nitrate nitrogen was down 11.74%, 25.32%, 25.12%, 76.61%, 17.79% and 27.14% from a year earlier, the TN content was unchanged, and the content of ammonium nitrogen was up 32.13%. Before the impoundment in September, the level of TP, TK, AP, AK, and nitrate nitrogen was down 1.54%, 10.65%, 74.05%, 11.69% and 17.57% respectively from a year earlier, the content of organic matters and ammonium nitrogen up 23.81% and 75.20%, and TN content basically unchanged.

### 8.3.2 Re-vegetation

Up to 83 species of vascular plants which fell into 73 genera of 32 families were identified in the census on plant communities after the waters subsided this year. There were considerable amount of minor genus and monotypic genus species, specifically, monotypic genera accounted for 80.72% of the total genera. Moreover, the minor genus and monotypic genus species occupied 98.79% of the total species. The dominant vegetation

*Water level fluctuating zone*

was herbaceous plants; among others, the annual species accounted for 40.96% of the total species, and perennial species 30.55%. The percentage of arbor trees, shrubs, and liana plants was relatively low.

**8.3.3 Monitoring of biological media**

The mean density of rats in the monitoring sites of the water-level-fluctuating zone registered 1.11% this year, lower than that of last year (1.30%) and the same period of 2010 (1.86%). The mean density of rats was 1.29% after waters subsided this year, lower than that of last year (1.45%). The dominant rat species was *Apodemus agrarius*, which accounted for 57.14%. The mean density of rats before the impoundment recorded 0.89%, lower than that of last year (1.23%). The dominant rat species was also *Apodemus agrarius*, which accounted for 50.00%. The mean density was higher after waters subsided in June than prior to the impoundment in September. The dominant rat species after water subsidence and prior to the impoundment changed to *Apodemus agrarius* from *Anourosorex squamipes* in previous years. Banan District recorded the maximum mean density of rats among all monitoring sites after the water subsidence and before the impoundment this year, followed by Zhongxian County. The mean density of rats in Kaixian County and Zigui County was extremely low. And, the dominant rat species of Banan and Zhongxian was *Apodemus agrarius*.

The mosquito density in the monitoring sites of the water-level-fluctuating zone registered 3.91/zapper lamp/time, higher than the data of last year (3.47/zapper lamp/time). The mosquito density was lower prior to the impoundment in September than the data after water subsidence in June. *Culex pipiens fatigans* ranked the first in amount among trapped mosquitos (44.48%), followed by *Anopheles sinensis* (17.35%), *Armigeres subalbatus* (13.56%), and *Culex tritaeniorhynchus* (7.89%). *Aedes albopictus* was not observed. Banan District recorded the maximum mosquito density among all monitoring sites, followed by Kaixian County and Zhongxian County. The mosquito density went up in Kaixian County prior to the impoundment compared with the data after water subsidence; the situation was the other way around in Zhongxian County and Banan District. The mosquito density in the water-level-fluctuating zone was still far below that of residential quarters in the project area but had been on the rise. There was a certain percentage of *Culex tritaeniorhynchus* and *Anopheles sinensis* which are the main media of Japanese encephalitis and malaria.

The fly density in the monitoring sites of the water-level-fluctuating zone registered 1.88/flytrap/time. There were 10 species of flies. The dominant species was *Boettcherisca peregrina* (56 ones, 33.14%); followed by *Musca sorbens* (40 ones, 23.67%); *Aldrichina grahami* (21 ones, 12.43%); *Musca domestica* (20 ones, 11.83%), and *Calliphora vicina* (16 ones, 9.47%). A few of other species were also observed, including *Lucilia sericata, Lucilia cuprina, Lucilia illustris, Chrysomyia megacephala*, and *Fannia canicularis*. The fly density after waters subsided was 2.64/flytrap/time, higher than the data before the impoundment (1.26/flytrap/time); the two figures were a little higher than the same period last year (0.78/flytrap/time after waters subsided, and 1.13/flytrap/time before the impoundment).

## 8.4 Groundwater dynamics and soil gleization

The monitoring on groundwater dynamics and soil gleization indicators continued in 2012 between Shimatou Village and Xiaogang Farm, Honghu City in the four-lake region of the midstream of Yangtze River.

**8.4.1 Groundwater dynamics**

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 this year was much higher than

the data of last year in the monitoring sites, but the fluctuation was milder within the year. The mean annual groundwater table at the observation wells was up 0.21 m from a year earlier. Among others, the confined water table was up 0.11～0.33 m, and the phreatic water table was up 0.12～0.39 m. The increment of phreatic water table was above that of confined water table. Moreover, the fluctuation of groundwater table ranged between 0.73～2.08 m within the year, and the average fluctuation was 1.35 m, down 0.30 m from a year earlier. The farther an observation well was away from the Yangtze River, the lower the water table increment was and the milder the fluctuation.

The groundwater table ascended early and descended late this year, so high water table was maintained for a long period. The maximum mean monthly water table was observed between June and August, and the minimum mean monthly water table was observed in January and February. Analysis of the water table for the whole year indicated water table started to ascend as of January and reached the maximum in June; maintained high from May through September; and began to descend as of September.

#### 8.4.2 Soil gleization

Seven soil profiles between Xiaogang Farm and Shimatou Village in Honghu City and three soil profiles in Xinxing Dyke of Jianli County were monitored for soil gleization conditions in the summer and winter this year. The monitoring indicators included soil moisture content, pH value, oxidation reduction potential, the total amount of reductive substances, the content of active reductive substances, and the content of ferrous iron.

Monitoring data showed the mean annual total amount of reductive substances was 2.48 centimol/kg, up 16%/0.35 centimol/kg from the previous year. The mean annual content of active reductive substances was 1.45 centimol/kg, up 10%/0.13 centimol/kg from a year earlier. Analysis of mean seasonal data showed, the total amount of reductive substances was up 7% in the summer and 34% in the winter, and the content of active reductive substances was up 3% in the summer and 27% in the winter compared with the respective mean seasonal data of last year. The increment in the winter was much more dramatic than in the summer. The variation of the content of other indicators such as ferrous iron exhibited the same characteristics. Therefore, the soil gleization aggravated compared with last year, which could be attributed to rising water tables.

## 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 2012 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 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 Yangtze River waters**

Monitoring data at the aforementioned sections showed the conductivity of Yangtze River waters was high in the spring, autumn, and winter, and low in the summer. The upstream runoff variations and water level fluctuations of the River affected the dynamic change of the salinity at those sections. As Yangtze River had abundant runoff and high water level this year, the conductivity monitored at each of the monitoring sections went down compared with last year, but went up significantly from the 2010 baseline; the year 2010 had similar runoff as this year. The salinity observed at Yinyang and Daxing from September to October was above mean annual salinity. The mean annual conductivity of river waters at Yinyang Section dropped a little from last year, but the salinity between September and October was significantly higher than mean annual data; the conductivity in October was even approximate to the data of the same period last year. The mean annual conductivity of river waters at Daxing Section went down 25.7% from a year earlier, but the conductivity recorded from September to October was above mean annual value and approximate to the same period last year. The mean annual conductivity of river waters at Xinglongsha Section was down 26.3% from a year earlier and the value observed between September and November also dropped dramatically.

- **Conductivity of inland river waters**

The conductivity of inland river waters was lower near the south bank of the north branch than near the north bank. The conductivity monitored at monitoring sections went down compared with last year, which


*Water–salt dynamics and soil salinization mionitoring site*

might be attributed to abundant runoff from upstream. However, the conductivity of inland river waters at Yinyang and Daxing monitoring sections between September and October was above annual average. At Yinyang Section, the mean annual conductivity of inland river waters was down 12.5% from a year earlier, and above annual average from September to October. The conductivity recorded in October was even approximate to the same period of 2011, a low flow year. The conductivity between September and October was up 35.1% compared with the same period of 2010. At Daxing Section, the mean annual conductivity of inland river waters was down 28.2% from a year earlier, but a little higher than the data of 2010, which has approximate runoff. The increment of conductivity was more dramatic in the autumn. At Xinglongsha Section, the conductivity of inland river waters went down more significantly than other two sections. There was very significantly positive correlation between conductivity of inland river waters and that of the Yangtze River waters at the three monitoring sections in the estuary. Therefore, the conductivity of the Yangtze River waters was closely related to that of inland river waters.

● **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. The mean annual groundwater depth of the three monitoring sections went down from a year earlier, affected by the upstream runoff variations and water level fluctuations of the Yangtze River. The mean annual groundwater depth was down 13.7% from a year earlier at Yinyang Section, but up a little from the baseline of 2010 which has approximate annual runoff. The groundwater depth went up to some extent due to lowered water level of the River from September to October at Yinyang. At Daxing Section, the mean annual groundwater depth was also down 13.7% from a year earlier, but in September the groundwater depth was higher compared with the same period last year, which might be attributed to the fast shrinking runoff and lowering water level of the River in September. The mean annual groundwater depth at Xinglongsha Section was a little shallower than last year, but up 11.8% compared with the year 2010.

● **Groundwater conductivity**

The conductivity of groundwater at the three monitoring sections climbed up to some extent, which might be attributed to rising water level of the River which increased the supplement of salt by surface water to groundwater. The mean annual conductivity of groundwater at Yinyang Section was up 6.8% from a year earlier, and up 9.8% from the 2010 baseline. The conductivity of groundwater at Daxing Section was higher than the same period last year, and up 76.8% in the autumn (between September and October); the increment was even greater from the 2010 baseline. The mean annual conductivity of groundwater at Xinglongsha Section was up 12.2% from a year earlier; and the increment was even greater from the 2010 baseline. 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 Yangtze River waters and of inland river waters.

**8.5.2 Soil salinization**

The soil conductivity of the monitoring sections in

*Collection of automatic monitoring data*

the estuary went up to varied degrees this year. The soil conductivity of Yinyang Section which was nearest to the estuary was higher than the data monitored at Daxing Section and Xinglongsha Section.

The mean annual soil conductivity of Yinyang Section was approximate to the data of last year, but the conductivity went down a little in the autumn (from September to November), which could be attributed to the abundant precipitation during this period. The mean annual soil conductivity rose sharply from the 2010 baseline at Yinyang, so did the mean conductivity from September through November. The soil conductivity also increased significantly compared with the data before the impoundment. The mean annual soil conductivity of Daxing was up 14.3% from a year earlier and up 27.6% from the 2010 baseline, while the data for Xinglongsha was up 9.3% from a year earlier, and approximate to the data of 2010. The mean conductivity of soil at Xinglongsha between September and November was up from the 2011 and 2010 levels. The conductivity of top soils at Yinyang, Daxing, and Xinglongsha sections was significantly correlated to the groundwater conductivity, which demonstrated groundwater salinity was an important factor affecting soil salinity. The soil conductivity at Xinglongsha also had significantly negative correlation to the groundwater depth, which means the groundwater depth constrained the effect of groundwater salinity on soil salinity.

The analysis data of soil samples collected regularly from monitored plots this year showed the soil salinity was on the increase and reached slight-moderate salinization in some of the fixed-site sample plots in Yinyang. There was considerable soil salinity 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**

The geographical variations of the temperature of surface layer waters in the estuary were different from those of bottom layer waters in the spring. The temperature of surface layer waters was high in the estuary and southeastern infralittoral waters, and low near the coastline and in the northeastern infralittoral waters. The temperature of bottom layer waters was high in the estuary and low in the infralittoral waters, and the maximum temperature registered 20.04℃, and the minimum 12.63℃. In the autumn, the temperature was low near the coastline and high in the infralittoral waters, and distributed evenly in the vertical dimension. The maximum temperature registered 20.75℃ and the minimum 15.16℃. The temperature of upper surface layer waters was a little lower than the data of deep bottom layer waters. The geographical variations of the water temperature in the spring were different from last spring, whereas the variations in the autumn were similar to last autumn. But, the water temperatures in the autumn were lower than that of last autumn, with the maximum temperature down 0.27℃, and the minimum down 2.68℃.

In the spring, the tongue-shaped diluted waters in the estuary extended eastwards, and 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 31.79. In the autumn, the geographical variations of water salinity in the estuary were mainly affected by the diluted waters of the 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 33.22. The maximum salinity was down 0.38 from a year earlier, but the geographical variations of salinity were basically the same in two autumns.

Affected by Yangtze River waters, the SD of the estuary waters was low in the estuary and near the coastline and high in the infralittoral waters. Among others, the SD was generally below 0.5 m to the west of E122°30′, between 1 and 2 m from E122°30′to E123°00′, and above 2 m to the east of E123°00′. The maximum SD was 3.0 m, similar to the data last year.

● **Hydrochemical elements**

The mean content of dissolved oxygen in the surface layer river waters in the estuary was 6.90 mg/L in the spring and 9.12 mg/L in the autumn. The mean content of dissolved oxygen in the surface layer seawaters in the estuary was 9.55 mg/L in the spring and 7.84 mg/L in the autumn. The mean content of dissolved oxygen of surface layer waters was higher than that of bottom layer waters outside the estuary, and dropped with growing water depth. The mean content of dissolved oxygen of river waters in the estuary was on the low side in the spring and on the high side in the autumn compared with the same period last year, while the mean content of

dissolved oxygen of seawaters in the estuary was on the high side in both spring and autumn.

The pH value averaged 7.77 in the spring and 8.11 in the autumn in the surface layer river waters in the estuary, and 7.82 in the spring and 8.13 in the autumn in the bottom layer river waters. The pH value averaged 8.20 in the spring and 8.43 in the autumn in the surface layer seawaters in the estuary, and 8.08 in the spring and 8.47 in the autumn in the bottom layer seawaters. The geographical variations of pH value in the estuary showed the pH value was low in the estuary mouth, and high outside the estuary mouth in seawaters. The pH value of river waters in the estuary had slight variation in the spring, and was on the high side in the autumn compared with last year; while the pH value of seawaters in the estuary was obviously on the high side in both spring and autumn compared with last year.

The mean content of COD registered 2.45 mg/L in the spring and 3.28 mg/L in the autumn in the surface layer river waters in the estuary, and 2.62 mg/L in the spring and 3.87 mg/L in the autumn in the bottom layer river waters. The mean content of COD was 1.95mg/L in the spring and 1.29 mg/L in the autumn in the surface layer seawaters in the estuary, and 1.81 mg/L in the spring and 1.76 mg/L in the autumn in the bottom layer seawaters. Affected by the diluted waters of Yangtze River, the COD content was high near the coastline and low in the open sea. For river waters, the year-on-year COD content was lower in the spring and higher in the autumn, but the difference was minor. For seawaters, the year-on-year COD content was lower in the surface waters in the autumn, and higher in the bottom waters in both spring and autumn.

The horizontal variations of phosphate, silicate, nitrate, TN, and TP content exhibited the following tendency-lowering fast from the estuary towards the open sea. The variations of ammonia nitrogen and nitrite contents were more complicated. The following nutrient salts exhibited different law of variation compared with last year. The year-on-year phosphate content was higher in the spring and lower in the autumn in Yangtze river waters, and lower in both spring and autumn in the estuary seawaters. The year-on-year silicate content rose significantly in the spring and was lower in the autumn in the river waters; and higher in the spring and varied little in the autumn in the estuary seawaters. The year-on-year nitrate content was higher in the spring and lower in the autumn in river waters and estuary seawaters. The year-on-year nitrite content was higher in the spring and lower in the autumn in the river waters; it dropped remarkably in the estuary seawaters. The year-on-year content of ammonia nitrogen was much lower in the spring and varied little in the autumn in river waters; it declined sharply in the estuary seawaters. The year-on-year TN content rose significantly in the spring and varied little in the autumn for river waters; it plummeted in the estuary seawaters. The year-on-year TP content in the surface and bottom layers of river waters was lower in May and higher in November. The year-on-year TP content in the surface and bottom layers of estuary seawaters was almost unchanged in May and higher in November.

● **Sediment elements**

The content of suspended matters in the estuary waters was much higher in the autumn (207.15 mg/L on average) than in the spring (119.52 mg/L on average) this year. There were significant seasonal variations in the content of suspended matters in the surface layer waters, which was 125.55 mg/L on average in the spring and 181.74 mg/L on average in the autumn. There were minor seasonal variations in the content of suspended matters in the bottom layer waters, which was 254.94 mg/L on average in the spring and 394.38 mg/L on average in the autumn. The year-on-year content of suspended matters was lower in the spring and higher in the autumn. The geographical variations of the content of suspended matters changed little this year. The only difference was, last year there was a patch of waters in the north of Shengsi Island recorded with high content of suspended matters in the surface waters in the spring, and this spring no such patch of waters was observed.

### 8.6.2 Biological elements in waters

● **Chlorophyll-a**

The concentration of Chlorophyll-a was much higher in the spring than in the autumn in the estuary waters. In the spring, the concentration of Chlorophyll-a in the surface waters ranged between 0.09～3.51 mg/L and averaged 0.69 mg/L. The patch of waters with high Chlorophyll-a concentration was mainly distributed in the eastern part of the monitored seawaters. Minimum concentration of Chlorophyll-a was observed in some waters in the estuary mouth. The sediment runoff caused high turbidity in the estuary mouth and the southwestern part of the monitored seawaters, and thus low concentration of Chlorophyll-a was observed. Taiwan warm currents intrusion had significant impact on the southeastern part of the monitored seawaters,

Table 8–1 Nutrient salt contents in the Yangtze River estuary in the spring and autumn of 2012

Unit: μmol/L

| Season | Nutrient salt | Yangtze River waters | | Estuary seawaters | |
|---|---|---|---|---|---|
| | | Surface layer | Bottom layer | Surface layer | Bottom layer |
| Spring | Phosphate | 2.0 | 2.0 | 0.46 | 0.52 |
| | Silicate | 88.4 | 88.5 | 20.6 | 17.7 |
| | Nitrate | 137.2 | 137.0 | 35.2 | 26.1 |
| | Nitrite | 1.7 | 1.2 | 0.56 | 0.54 |
| | Ammonia nitrogen | 1.8 | 9.8 | 0.5 | 0.47 |
| | TN | 174.7 | 174.8 | 46.7 | 39.9 |
| | TP | 2.6 | 3.0 | 1.7 | 2.3 |
| Autumn | Phosphate | 1.2 | 1.2 | 0.82 | 0.75 |
| | Silicate | 87.7 | 87.4 | 27.4 | 23.8 |
| | Nitrate | 109.5 | 110.6 | 21.5 | 18.6 |
| | Nitrite | 0.67 | 0.71 | 0.31 | 0.31 |
| | Ammonia nitrogen | 3.3 | 2.3 | 1.5 | 2.0 |
| | TN | 146.4 | 147.5 | 38.6 | 37.0 |
| | TP | 4.8 | 4.4 | 3.0 | 4.7 |

by increasing the photopermeability of the seawaters, facilitating the photosynthesis of phytoplankton, and creating high Chlorophyll-a value.

In the autumn, the concentration of Chlorophyll-a in the surface waters ranged between 0.13～0.66 mg/L and averaged 0.22 mg/L. The patch of waters with high Chlorophyll-a concentration was mainly located in the south estuary, while the patch of waters with low Chlorophyll-a concentration was in short seas. The growth of phytoplankton was not vigorous in the autumn, and land sources became the major source of Chlorophyll-a in the monitored seawaters.

● **Fish zooplankton**

A total of 1,493 fish zooplankton was caught in the spring, including 1,394 spawns and 97 larvae. They fell into 8 species, 7 families, and 5 orders. The dominant species of fish zooplankton in the estuary waters were *Engraulis japonicus* and *Pseudosciaena polyactis* in the spring. The abundance of fish zooplankton in the spring varied little compared with last year. *Engraulis japonicus* remained the top dominant species, while the dominance of *Pseudosciaena polyactis* elevated.

A total of 260 fish zooplankton was caught in the autumn, including 83 spawns and 177 larvae. They fell into 10 species, 9 families, and 7 orders. The abundance of fish zooplankton and the number of their species varied little in the autumn compared with last autumn. The dominant fish zooplankton was *Stolephorus commersonii* and *Trichiurus haumela* spawns. The abundance of fish species and dominant species composition in the autumn varied little compared with last year.

● **Fishery resources**

There were 78 species of fishes and macro invertebrates caught in the spring, which included 53 fish species, and 25 species of macro invertebrates. *Setipinna taty* and *Vespicula trachinoides* were the dominant species, whose resource abundance was 13,090/km$^2$ and biomass 125.39 kg/km$^2$. A total of 42 species of fishes which fell into 27 families in 8 orders were caught in the autumn, with the dominant species as *Setipinna taty, Harpodon nehereus* and *Trichiurus haumela*, whose resource abundance was 35,260/km$^2$, and biomass 1,025.51 kg/km$^2$.

The number of resource species varied little compared with the same period last year. There was a reshuffle among the dominant species in the spring, *Harpodon nehereus* and *Pampus argenteus* were not dominant species any more, and the dominance of *Vespicula trachinoides* elevated. *Trichiurus haumela* and *Harpodon nehereus* championed its dominance in the autumn, while *Setipinna taty* made it to be among dominant species. The fishery resource density dropped a little from a year earlier, especially during the spring, which revealed fluctuations in the fishery resources in the estuary.

## 8.7 Wetlands in the midstream

### 8.7.1 Dongting Lake

● **Streamflow**

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

The incoming flow of Dongting Lake waters was basically in normal conditions this year. Monthly data indicated the incoming flow was down over 10% in April, up around 10% in May and September, down nearly 20% in August and October, and unchanged in the remaining months compared with the same period of average year. The annual precipitation observed at Chenglingji Station at the lake outlet registered 1,654.4 mm, up over 75% from a year earlier; the maximum water level of the year 33.38 m, the minimum water level 20.59 m, and the average water level 25.81 m; the annual runoff was approximate to the historical average and up 94% from a year earlier; the annual sediment discharge amounted to 256 billion t, down 34% from historical average and up 75% from a year earlier.

The 60-day flood inflow statistics showed the total inflow of the lake reached 83.49 billion $m^3$, the total outflow 84.39 billion $m^3$, and the buffering balance -0.90 billion $m^3$ this year. Analysis of the flood inflow contributors at Chenglingji Station (Qili Mountain) demonstrated the four inflow rivers contributed 85.9% of the incoming flow to the lake in 7 days, 50.6% in 15 days, 48.8% in 30 days, and 57.8% in 60 days. The three bleeders of the Yangtze River contributed 13.7% of the incoming flow to the lake in 7 days, 49.2% in 15 days, 50.3% in 30 days, and 39.7% in 60 days. The interval inflows contributed the least of source waters to the lake, which is, 0.4% in 7 days, 0.2% in 15 days, 0.9% in 30 days, and 2.5% in 60 days. Analysis of the contributors of monthly runoff at Chenglingji Station showed 79.0% of the Dongting Lake inflow came from the four inflow rivers between June and October, and 67.0% in the remaining months. Over 59.1% of the incoming flow observed at Luoshan Station was contributed by Yangtze River.

The maximum discharge of the runoff into the Three Gorges Reservoir recorded 71,200 $m^3/s$ this year. There was no encounter of bad consequences between upstream runoff and midstream and downstream floods, owning to the magnificent flood control capacity of the Reservoir. Yangtze River fed a lot of source waters into Dongting Lake through the three bleeders from January through May. The minimum water level observed at Chenglingji Station in the year was much higher than previous years.

● **Water quality**

The four inflow rivers among the upstream runoffs of Dongting Lake enjoyed good water quality this year. The monitoring sections where Xiangjiang River, Zishui River, Yuanjiang River, and Lishui River empties into the lake attained Grade II water quality standard. The three bleeders recorded improved water quality which attained mostly Grade II~III standard. The lake outlet observed unchanged water quality at Grade III standard. The eight monitoring sections across the lake area attained mostly Grade IV water quality standard and failed to meet the requirements for water functional zones. TP and TN pollution was serious, TP concentration attained Grade III~IV standard and TN concentration Grade V standard or poorer. From the perspective of geographical distribution, western lake waters recorded good water quality, while southern and western lake waters had poor water quality. Up to 66.7% of all the 16 monitoring sections attained Grade I to III water quality standard, which implied slight pollution. The main pollution indicators were TP, TN, and dissolved oxygen.

The TLI of Dongting Lake ranged between 44.4 and 48.7 this year, and the lake as a whole was in mesotrophic state. The maximum TLI was recorded in Lujiao Section which was in eutrophic state. The trophic level of eastern lake was a little higher than that of

western and southern lake. Monthly data indicated the entire lake was in mesotrophic state, and the TLI was relatively high in January and July, as much as 48.0.

A total of 81 genera of phytoplankton were identified in Dongting Lake, which fell into 8 phyla. There were 33 genera under Chlorophyta, which topped the list; followed by 26 genera under Bacillariophyta, 10 genera under Cyanophyta, 4 genera under Euglenophyta, 4 genera under Pyrrophyta, 2 genera under Cryptophyta, one genus under Chrysophyta, and one genus under Xanthophyta. Apart from Chrysophyta and Xanthophyta, the other 6 phyla of phytoplankton could be observed throughout the year and all over the lake. There were no distinct seasonal variations in the species of phytoplankton, and the dominant species had always been Chlorophyta and Bacillariophyta species, followed by Cyanophyta species. There were remarkable seasonal variations in the phytoplankton population in the lake. The population peaked in March and seconded by June. There were fewer phytoplankton in September and December.

● **Vegetation**

The fixed-site observation data on 6 typical islets and shoals (Liumen Gate, Beizhouzi, Tuanzhou, Junshan, Chunfeng, and Jianxing Farm) showed the representative vegetation communities of the lake, i.e., *Triarrherca sacchariflora, Carex tristachya*, and *Polygonum flaccidum* communities exhibited distinct seasonal differences. Among others, the number of species of *Triarrherca sacchariflora* community peaked in April (29 species); the species richness index was low in January (4.8) and had no significant differences (ranging between 6.7 and 7.8) during the remaining three months; the species diversity index was the maximum in March (0.80), and minimum in November (0.45). The coverage of the community peaked in April (108.1%) and hit the bottom in January (37.3%). The number of species of *Carex tristachya* community was the lowest in April (7 species) and exhibited little difference in the remaining three months (11～13 species); the species richness index was high in January (3.8), and low in April (1.8) and November (2.3); the species diversity index was high in March (0.37) and low in the rest of three months (0.16～0.21); the coverage of the community was low in March (91.7%) and exhibited little difference in the remaining three months (94%～103.7%). The number of species of *Polygonum flaccidum* community was high in March (9 species) and low in November (2 species) and January (3 species); the species richness index was high in March (4.4) and exhibited little difference in other three months (1.8～3.0); the species diversity index was low in November (0.23) and high in March (0.48) and April (0.44); the coverage of the community was the lowest in March (69.8%), and showed little difference during other three months (95.8%～132.2%).

● **Biodiversity**

There was little variation in the bird species of eastern Dongting Lake this year compared with last year. There were 55 species of wintering water birds which fell into 9 families in 6 orders, and 76 species of summer migrant birds which fell into 31 families in 10 orders this year, as opposed to 51 wintering bird species and 82 migrant bird species in the previous year. There was a decline in the bird populations which were dominant by wintering water birds. Up to 104,223 wintering water birds were observed in January, down 30.5% from a year earlier (150,006). The reduction in population of *Anser fabalis, Anser albifrons*, and *Calidris alpina* was the most drastic. *Grus monacha* population dropped the most drastically among the bird species under I-level state key protection, from 14 down to 4; the population of *Anser erythropus* was stable and above 20,000. The species under major monitoring program amounted to 46,833, up 14,740 from a year earlier (32,093). The population of *Cygnus columbianus* and *Anas falcata* increased remarkably. The analysis of interspecific distribution pattern of bird species in the eastern Dongting Lake indicated Anatidae accounted for nearly 74% of the total bird species, and their major habitats are islets and shoals and main feed are grass there; there were many species of waders but their population was small, and their main habitats are mudflats or shallow waters and main feed are benthos and small fishes. Analysis of spatial distribution pattern of bird species in eastern lake showed the main distribution area of the birds in the eastern lake was stable, and it mainly covered waters to the east of Zhuzi River inlet into Baihu Lake and Heizui waters, the enclosed management zone of major and minor West Lake, and the bund of Chunfeng Lake.

The monitoring data of *Elaphurus davidianus* showed the population of wild *Elaphurus davidianus* in the nature of eastern Dongting Lake ranged between 50 and 70 and went upward slowly. *Elaphurus davidianus* was mainly distributed in Heizui (end of Zhuzi River) (population 34～45) and Piaowei (Hongqi Lake) (population 16～25) regions. The data of two monitoring programs on *Microtus fortis* showed one *Microtus fortis* was trapped in January, accounting for 0.61%; and two

trapped in May (1.02%). The population of *Microtus fortis* was up compared with last year.

### 8.7.2 Poyang Lake

● **Streamflow**

As the largest freshwater lake in China, Poyang Lake is located in the south of Yangtze River in the northern Jiangxi Province. The lake embraces inflow 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 waters empty into Yangtze River at the lake outlet.

The annual precipitation of Poyang Lake registered 1,791.6 mm, up 28% from a year earlier and up 25% compared with the historical average. Analysis of geographical distribution of precipitation found there was plenty rain in the south and little rain in the north of the lake. The incoming runoff and water level of the lake were on the high side this year, so the water supplement of the lake was above moderate this year. The maximum water level within the year was 19.65 m observed at Xingzi Station, the minimum water level 7.79 m, and the mean water level 13.76 m. The combined runoff contributed to the lake by the aforementioned five major inflow rivers recorded 174.3 billion $m^3$, up 139% from a year earlier, and up 39% compared with historical average. The incoming sediments amounted to 9.51 million t, up 108% from a year earlier and down 31% from historical average. The runoff discharge of the lake through outlet to Yangtze River totaled 211.3 billion $m^3$ this year, up 118% from a year earlier and up 40% from historical average. The sediment discharge of the lake amounted to 14.04 million t, up 84% from a year earlier, and up 41% from historical average.

*Sampling of econmic fish*

There were backflow of Yangtze River waters into Poyang Lake on two occasions within the year. The first backflow was observed between 10:00 on July 14 and 20:00 on July 16, with the average discharge of 2,839 $m^3/s$, maximum discharge of 5,040 $m^3/s$, and backflow volume up to 603 million $m^3$. The second backflow was observed between 10:00 and 12:00 on August 2, with the discharge at 460 $m^3/s$ and backflow volume up to 30 million $m^3$. The combined backflow volume of Yangtze River waters was up 481 million $m^3$ compared with last year.

The 60-day flood inflow recorded from May to July indicated the total inflow of the lake reached 68.946 billion $m^3$, the total outflow 63.79 billion $m^3$, and the buffering balance 5.156 billion $m^3$ this year. The contributing runoffs of Poyang Lake were mainly the five major inflow rivers and interval waters. Among others, Ganjiang River has always been the dominant inflow river of the lake and contributed 54.0% of the total inflow, followed by Xinjiang River which contributed 16.9%.

● **Water quality**

The inflow rivers of Poyang Lake enjoyed good water quality this year. Up to 76.4%～92.7% of the river waters attained Grade I~III standard, with the average percentage at 87.8%, down 6.0% from a year earlier. The ranking (from good to poor) of water quality among those rivers was Xiuhe River, Ganjiang River, Xinjiang River, Fuhe River, Chang River (Raohe River) and Le'an River. Among others, Xiuhe River and Ganjiang River attained Grade III or better water quality standard throughout four quarters of the year; Le'an River failed Grade V water quality standard, and the main pollutants were ammonia nitrogen and TP. The monitoring section at the lake outlet attained Grade III or better water quality standard from the second through the fourth quarter; it attained Grade IV standard in the first quarter, and the main pollutant was ammonia nitrogen. Among the 15 monitoring sections in the lake area, the percentage of sections which attained Grade I~III standard ranged between 46.7% and 86.7%, and averaged at 71.7%, up 3.4% from a year earlier. The main pollutants were ammonia nitrogen and TP.

The geographical variations of TN and TP content showed high value recorded at the inlet of tributary rivers and the lakeside waters, and low value in the lake

center. In the dry period from December through March, the main eutrophic area was the major lake area in the lake center (Duchang waters), which had high risk of eutropher. In the rising flood season from April to June, the risk of eutropher at the northern lake where lake waters meets Yangtze River waters dropped significantly, and the high risk waters was mainly Duchang waters. In the high water period between July and September, the eutropher risk of Poyang Lake was low in general and a little higher in the lake inlet (Wucheng) of the major tributary Ganjiang River and in the Laoyemiao waters. In the water subsiding period from October to December, the eutrophic waters moved towards downstream to the northern lake where lake waters meet the Yangtze River waters.

● **Vegetation**

In 2012, the zonary belts of *Artemisia selengensis, Carex cinerascens*, and *Phalaris arundinacea* and mudflats distributed on the islets and shoals were monitored top-down in respect of elevation. Analysis data of the height of dominant species showed, the maximum height of *Artemisia selengensis* registered 62.2 cm in the spring and 112.5 cm in the autumn; of *Carex cinerascens* 50.8 cm in the spring and 36.5 cm in the autumn; and of *Phalaris arundinacea* 58.7 cm in the spring, far beyond the autumn data of 21.9 cm. The dominant species on the mudflats was *Rumex japonicus* Houtt. in the spring with maximum height of 45.9 cm, and *Lobelia chinensis* in the autumn with the maximum height of only 8.9 cm. Analysis data of biomass indicated the surface biomass of *Artemisia selengensis* belts was 4,532.2 g/m$^2$ in the autumn, far beyond the data in the spring (2,563.5 g/m$^2$); of *Carex cinerascens* belts 1,687.3 g/m$^2$ in the spring and 725.3 g/m$^2$ in the autumn; and of *Phalaris arundinacea* belts 2,057.2 g/m$^2$ in the spring and 653.2 g/m$^2$ in the autumn. The biomass of *Carex cinerascens* and *Phalaris arundinacea* in the spring was far beyond the data in the autumn, as opposed to *Artemisia selengensis*. The surface biomass on the mudflats registered 865.4 g/m$^2$ in the spring, significantly above the autumn data at 225.4 g/m$^2$. Analysis of community biodiversity (the Shannon-Wiener index) showed mudflats recorded the maximum values, which is, 1.536 in the spring, and 1.638 in the autumn. In the spring, *Carex cinerascens* belts observed the minimum community biodiversity of merely 0.267, while in the autumn, *Artemisia selengensis* belts recorded the minimum value at 0.457.

As for soil bulk density, *Carex cinerascens* belts recorded the minimum value at 0.87 g/cm$^2$ in the spring and 0.91 g/cm$^2$ in the autumn; followed by *Phalaris arundinacea* belts (0.89 g/cm$^2$ in the spring and 0.92 g/cm$^2$ in the autumn), and then *Artemisia selengensis* belts (0.96 g/cm$^2$ in the spring and 0.95 g/cm$^2$ in the autumn). The soil bulk density of mudflats registered 1.126 g/cm$^2$ in the spring and 1.15 g/cm$^2$ in the autumn, higher than other vegetation belts. As for soil moisture, *Carex cinerascens* belts registered the maximum values, which were, 47.2% in the spring and 45.5% in the autumn; the soil moisture for *Phalaris arundinacea* belts was 45.3% in the spring and 49.1% in the autumn; and the data for *Artemisia selengensis* belts was 36.9% in the spring and 45.8% in the autumn. The soil moisture of mudflats was far below the data of other vegetation belts, and registered 32.8% in the spring and 40.5% in the autumn.

● **Biodiversity**

Over 419,700 wintering water birds of 58 species were recorded in the simultaneous census on wintering water birds throughout the lake on December 25. As for the population of key species, there were 1,966 *Grus leucogeranus*, 96 *Grus monacha*, 221 *Grus vipio*, 502 *Grus grus*, 1,339 *Ciconia boyciana*, 5,535 *Platalea leucorodia*, 62,631 *Cygnus columbianus*, 67,181 *Anser cygnoides*, and 33,242 *Anser albifrons*. The population of wintering migrant birds was down over 170,000 compared with last year, and the population of large water birds such as cranes, storks and Anatidae dropped significantly.

Up to 50 species of water birds in 13 families, 6 orders were observed during the regular censuses on wintering water birds within Poyang Lake National Nature Reserve. Among others, 37 species were identified from January to March and 49 from October to December.

*Survey on vegetation on islets and shoals of Poyang Lake*

As for the maximum population of key species, it was 2,481 of *Grus leucogeranus*, 170 of *Grus monacha*, 779 of *Grus vipio*, 490 of *Grus grus*, 1,581 of *Ciconia boyciana*, 5,255 of *Platalea leucorodia*, 3,596 of *Cygnus columbianus,* 11,886 of *Anser cygnoides*, and 15,890 of *Anser albifrons*.

Up to 32 species of water birds were identified in the census on reproductive water birds in the summer, which fell into 12 families in 6 orders. Among others, there were 23 species of water birds observed in May, and 25 species in June. The number of Charadriiformes species (14 species) was the highest among the identified species, followed by 9 Ciconiiformes species.

## 8.8 Small watersheds in the upstream

**8.8.1 Yangjichong Watershed (Longli County, Guizhou Province)**

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 $km^2$, and the soil erosion area reached 7.41 $km^2$. The lands there are mainly used as woodlands and farmlands.

Longli Monitoring Station recorded 42 rainfalls across the year, with total precipitation at 598.1 mm, down 5.0% (31.4 mm) compared with last year. Among others, the precipitation in the flood season between May and September accounted for 74.5% of the annual, with maximum daily precipitation at 63.7 mm, maximum precipitation 63.7 mm, maximum monthly precipitation 193.2 mm, and maximum 30-min. precipitation 21.30 mm.

*Water and soil conservation measures in runoff plot*

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

The monitoring station at the outlet of the watershed observed 8 obvious floods throughout the year, mainly between May and November. The flood peak was observed on June 7, with discharge at 4.3 $m^3/s$. The annual runoff totaled 451,300 $m^3$ in the watershed. The bed load at the outlet totaled 4.01 t, and added by suspended load of 47.21 t, the annual soil erosion amounted to 51.22 t.

The monitoring indicators for soil physical and chemical properties included organic matters, TN, TP, TK, nitrate nitrogen, ammonium nitrogen, AP, AK, soil porosity, and soil mechanical composition. The monitoring data showed the ranking of the content of organic matters and TN was control plot＞woodland runoff plot＞grassland runoff plot＞cash trees runoff plot＞cropland runoff plot; the ranking of the content of TK and ammonium nitrogen was cash trees runoff plot＞woodland runoff plot＞control plot＞grassland runoff plot＞cropland runoff plot. The content of nitrate ammonia and AP was higher in cropland runoff plots than in other plots. The pH value of soils was the highest in cropland plots.

Calculated by the output concentration variations of the soil nutrients, the TN yield in the watershed totaled around 500 kg, and the TP yield about 85 kg. The evaluation results of individual indicators for water quality in accordance with *Environmental Quality Standards for Surface Water (GB3838-2002)* showed the watershed attained Grade II standard for ammonia nitrogen, Grade III standard for TP, and Grade IV standard for TN this year.

**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 $km^2$, the elevation ranges between 620 m and 1,340 m, and the mean altitude registers 992.51 m. The slope gradient of the watershed is 0～72.5º, and the mean gradient is 21.9º. The gradient of the largest patch of the watershed, which is up to 1.34 $km^2$, ranges between 15º～25º. The land use patterns included closed forest land, shrub land, orchard, dry land, rural residential quarters, 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 canopy density of closed forest lands averaged 50%, the coverage of scrub land averaged 40%, and the canopy density of orchard averaged 30%. The soil erosion in Maojiawan Watershed was mainly moderate (16,700 $km^2$) and severe (13,000 $km^2$) erosion, which accounted for 42.0% and 32.8% of the total erosion area.

The precipitation in the watershed registered 760.4 mm across the year, down 23%/229.8 mm compared with average year. Analysis of the runoff yields of runoff plots with varied slope gradients indicated the runoff yield was zero in 5º gradient plots, 131.02 $m^3$ in 15º gradient plots, and 177.47 $m^3$ in 25º gradient plots. The runoff yield of 25º gradient plots was much higher than that of 15º gradient plots. Analysis of sediment yield of different runoff plots indicated the sediment yield was zero in 5º gradient plots, 40.04 kg on average in 15º gradient plots, and 51.05 kg on average in 25º gradient plots. The sediment yield and erosion modulus of 25º gradient plots were much higher than those of 15º gradient plots.

According to the monitoring data on water quality of the surface runoff in those plots, there was zero runoff in 5º gradient plots. The annual COD yield of runoff (only) from 15º gradient plots was 6,255 mg, TN 3,613 mg, ammonia nitrogen 1,469 mg, nitrate nitrogen 2,144 mg, and TP 79 mg. The annual COD yield of runoff (only) from 25º gradient plots was 16,755 mg, TN 4,644 mg, ammonia nitrogen 1,469 mg, nitrate nitrogen 2,880 mg, and TP 137 mg. The annual yields of the runoff of 25º gradient plots were much higher than that of 15º gradient plots.

*An automatic weather station*

The monitoring data at the monitoring station of the watershed outlet showed the soil erosion amounted to 1,410 t, the mean discharge $1.35\times10^{-2}$ $m^3/s$, the maximum discharge 0.677 $m^3/s$, the total runoff 424,700 $m^3$, the mean annual sediment discharge rate $3.23\times10^{-4}$ kg/m, the maximum sediment discharge rate 0.02 kg/s, and the annual sediment discharge 10.20 t.

**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 around 390 m, and relative relief around 90 m. Dawan Stream as a typical tributary was selected as a monitoring target, and the monitored area covered 0.33 $km^2$.

Yibin Monitoring Station recorded 182 rainfalls this year, and the combined precipitation registered 1,277 mm, doubling the data of last year, and up 173 mm from the historical average (1,104 mm). Among others, the precipitation in the flood season from May to September amounted to 1,034.1 mm, accounting for 81% of the annual precipitation. The precipitation in the dry season (January through April, and October through December) registered 242.9 mm, accounting for 19% of the total. The maximum daily precipitation was observed on September 11 at 90.2 mm.

The ranking of runoff yield and sediment yield of runoff plots with different tillage systems was bare land plot (control plot)＞flat land tillage plot＞grain crop, cash crop and fruit tree tillage plot＞contour ridge tillage plot＞contour ridge intercropping tillage plot＞contour hedgerow plot. The runoff yield of bare land plot (control plot) registered 21.134 $m^3$ and sediment yield 9.026 kg, both figures much higher than plots with other tillage systems. The runoff yield and sediment yield of a plot

increased with growing slope gradient.

The analysis of the physical and chemical properties of soil samples collected from runoff plots showed the content of organic matters exhibited little different among plots with different tillage systems; the ranking of TN content was similar to that of nitrate nitrogen content, which was flat tillage plot＞contour ridge tillage plot＞contour ridge intercropping tillage plot＞contour hedgerow plot. The soil porosity data had little difference among plots of different tillage systems.

Analysis data of the nutrient yields of plots with different tillage systems showed there was no noticeable difference in the TP output concentrations; the ranking of TN output concentrations in different plots was contour hedgerow plot＞contour ridge intercropping tillage plot ＞contour ridge tillage plot＞flat land tillage plot. The ranking of TN and TP losses among plots with varied tillage systems was consistent with that of runoff yield and sediment yield, which was bare land plot (control plot)＞flat land tillage plot＞grain crop, cash crop and fruit tree tillage plot＞contour ridge tillage plot＞contour ridge intercropping tillage plot＞contour hedgerow plot. The loss of soil nutrients was closely related to the runoff and sediment yields of the slopes, and slope gradient was a major factor affecting the non-point pollution output of the runoff plots; the nutrient loss increased with growing gradient.

The monitoring station at the outlet of the watershed observed 8 obvious floods throughout the year, mainly between May and October. The maximum discharge was 1.8 $m^3/s$. The annual runoff totaled 5,300 $m^3$ across the watershed. The bed load at the outlet totaled 1.41 t, and added by suspended load of 3.06 t, the annual soil erosion amounted to 4.47 t. The mean annual concentration of TN and TP in waters registered 1.37 mg/L and 0.31mg/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, and the landform is typical uplands. The catchment area of the watershed amounted to 0.0689 $km^2$, with minimum altitude of 280.0 m, maximum altitude 331.6 m, relative relief 51.6 m, and longitudinal river slope 2.92%. The historical average temperature registered 18.2℃, and the historical average precipitation 895.5 mm. The precipitation runoff empties into Fujiang River, an A-level tributary of Jialing River.

The MAT across the watershed registered 17.1℃, the maximum temperature was 38.5℃ observed on August 13, and the minimum temperature 0.5℃ observed on February 11. The annual precipitation totaled 1,022.5 mm, up 127.0 mm compared with the average year, and there were 120 days with rain throughout the year. The maximum daily precipitation was 116.9 mm as recorded on September 2, and the maximum monthly precipitation 268.2 mm in July. The annual water surface evaporation on land was 554.7 mm, and the maximum daily evaporation 5.5 mm on April 2.

Four major runoffs were observed during the following spells, i.e., July 21-24, July 31, August 18-19, and September 7-13. The combined runoff amounted to 14,285.2 $m^3$, and the sediment discharge totaled 22,169.8 kg. The sediment concentration was low and averaged at 1.55 $kg/m^3$. The maximum daily runoff was 2,017.8 $m^3$ on September 8, and the maximum daily sediment discharge was 2,780.1 kg observed on the same day.

The soil bulk density of the typical farmlands in the watershed ranged between 1.40 $g/cm^3$ and 1.60 $g/cm^3$. The bulk density of top soil was on the low side, and that of bottom layer soil was on the high side, with the difference around 10%. Top soil samples were collected from the runoff plots in April, May, June, July, and August, and the monitoring data showed the content of organic matters of soil samples from 012 plot averaged 6.8 g/kg, of nitrogen 2.2 g/kg, of phosphorus 0.7 g/kg, and of potassium 18.2 g/kg; the content of organic matters of soil samples from 014 plot averaged 7.1 g/kg, of nitrogen 3.2 g/kg, of phosphorus 0.8 g/kg, and of potassium 16.2 g/kg. The content of organic matters, nitrogen, and phosphorus was lower in the bottom layer soils than in the top soils, while the potassium content of bottom layer soils was approximate to that of top soils.

On typical days with rain, the content of nitrogen, TP and pH value recorded 0.5 mg/L, 0.28 mg/L, and 7.0 respectively on July 3, and 6.5 mg/L, 0.22 mg/L, and 6.5 on September 8.

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