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

2012

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

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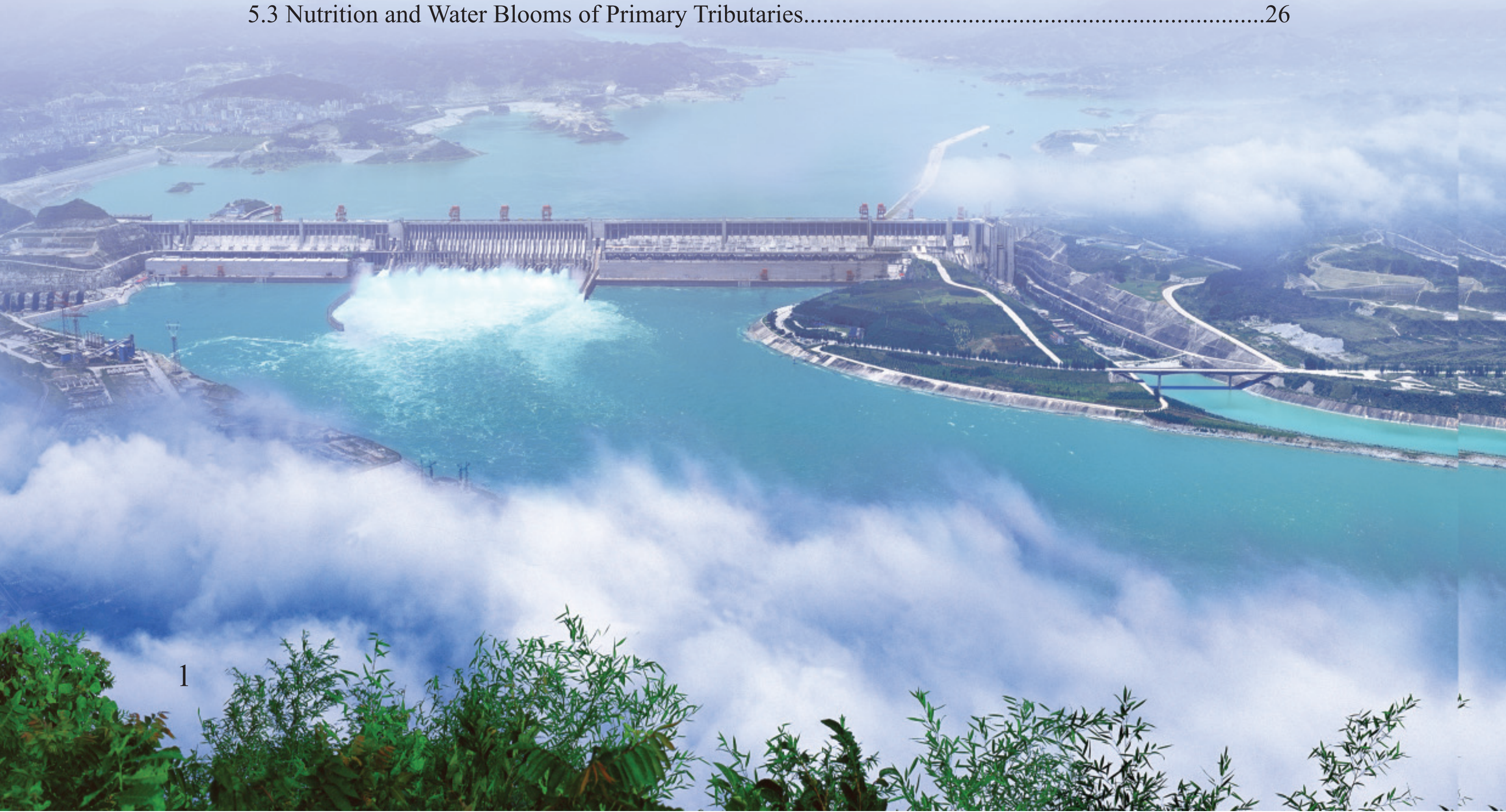
Content



Summary

In 2011, the Three Gorges Project had safe and smooth operation, The Three Gorges Project safely passed the flood season. The 175 meter trial impoundment was achieved once again at the end of rainy season. The annual freight volume of the Three Gorges navigation lock hit a new high in history with higher operation efficiency and new progress in maintenance and management. The construction of the building of underground power station and inception of the first group of generating units had passed national check and acceptance. The installation and debugging of 4 underground power generating units had been completed. The water and soil conservation facilities of the construction sites of the Three Gorges Project had passed post-construction check and acceptance organized by Ministry of Water Resources. The shiplift project and implementation of the plan for hydro complex administrative areas were under smooth progress.

The total registered population of the Three Gorges Project area was 16.7277 million, up by 0.7% compared with that of 2010. The public health of the people living in the Three Gorges Project area was good. The local GDP of the Three Gorges Project area was 444.466 billion yuan, up by 16.8% based on comparable price compared with that of last year. The added value of the primary, secondary and tertiary industry was 48.664 billion yuan, 263.659 billion yuan and 132.148 billion yuan respectively, up by 5.3%、21.7% and 11.6% respectively compared with that of 2010.

The annual average air temperature of the Three Gorges Project area was higher than the historical average, but annual average precipitation was less than the historical average. The air temperature was low in early winter but high in late winter with warm spring and hot autumn. The precipitation intensity was big in the summer with more rains in the autumn. The annual average evaporation was similar to the historical average. The annual average relative humidity was obviously lower than that of normal years. The annual average wind speed was less than the historical average. The annual average amount of foggy days was abnormally less than that of normal years.

There were 380864 ha arable land in the Three

Gorges Project area. The total sown area was 656741 ha. Agricultural produce was still dominated by grain crops.

The total catch of natural fish in the Three Gorges Reservoir, downstream section, Dongting Lake, Poyang Lake and estuary was 46500 t, down by 20.5% compared with that of 2010. The fry flow of the "four major home fishes" at Jianli section downstream the Dam wend down compared with that of last year and the fry flow process was not evident.

A total of 413 Management ⩾ 0.0 earthquakes were recorded from the head to the central part of Three Gorges Reservoir area with lower frequency and similar intensity compared with that of 2010. They maintained at minor and extremely slight quake levels. Earthquakes mainly concentrated on the areas in Badong County-Zigui County along the Yangtze River in Hubei Province. The monitoring and early warning of geological disasters such as collapse and landslips in the Three Gorges Reservoir area were in time and achievements have been made in prevention and control of risks and disasters.

The total discharge of waste water from industrial sources in the Three Gorges Project area was 191 million t. Among them, the discharge was 35800 t for COD and 2000 t for ammonia nitrogen. The total discharge of urban sewage was 706 million t. Among them, COD discharge was 144400 t and ammonia nitrogen discharge was 25800 t. The total application of pesticides in the Three Gorges Project area was 701.8 t, up by 18.3% compared with that of last year. The total applied amount of fertilizers was 155000 t, up by 11.5% compared with that of last year. The total amount of ship oil-containing waste water was 495900 t, 95% of them had been treated and 85% met national discharge standard. The ship sewage amount was about 3.889 million t.

The water quality of the mainstream of the Yangtze River in the Three Gorges Reservoir area was good in 2011. The Jialing River enjoyed excellent water quality in 2011. TP concentration in the Wujiang River went beyond the standard. 20.8%~39.0% water sections of major tributaries in the Three Gorges Project area were under eutrophication, same as that of the same period last year. There was water bloom in some tributaries of the Yangtze River.

Chapter 1
Operation of the Three Gorges Project

In 2011, the Three Gorges water project met the targets of annual plan. The operation of the hydro complex was safe and sound. The Three Gorges Project safely passed the flood season. The 175 m trial impoundment was achieved once again in the end of flood season. The annual shipment volume of the Three Gorges ship lock in the whole year reached a new historical high, with higher operation efficiency and new progress in maintenance and management. The construction of the building for underground power station and inception of the first group of generating units had passed check and acceptance by national authority. The installation and debugging of 4 underground generating units had been completed. The water and soil conservation facilities of the construction area of the Three Gorges Hydro Complex had passed the post-construction check and acceptance organized by Ministry of Water Resources. The implementation of the shiplift project and plan for hydro complex administrative area was under good progress.

● Comprehensive operation

In 2011, relevant authority continued the dynamically optimized operation of the Three Gorges Reservoir and kept on taking social and ecological benefits as the top priority. In May, the inflow of the upper and mid reaches of the Yangtze River was relatively less. The Three Gorges Reservoir released water four times to fight against drought from May 7 to June 10 with total volume at 5.47 billion m^3. It began releasing water for downstream navigation beginning from December 29, 2010. Up to 24:00 of June 10, 2011, the accumulated water release of the Three Gorges Reservoir to the downstream was 21.5 billion m^3, 164 days of water replenishment with average increase of water level of the channel at about 1 m. To promote natural breeding of the "four major home fishes" in river section downstream Yichang, the Three Gorges Reservoir conducted ecological water regulation trial during June 16~19, adding the discharge flow for four days with increase of about 2000 m^3/s of average daily outflow. The monitoring results indicate positive role of this ecological dispatch of water to the breeding of the "four major home fishes" in Yichang-Yidu river section.

● Operation of hydro complex and power station

The Three Gorges Reservoir reached the primarily designed 175 m normal impoundment level once again on October 30, 2011. The entire water storage process was safe and sound and the Three Gorges Water Project had smooth operation. The total generated electricity of the Three Gorges Reservoir-Gezhouba cascade hydropower stations was 94.55718 billion kW•h in 2011. The total output of the Three Gorges Power Station (29 generating units) reached 20.30 million kW for the first time at 8:00 of August 8, 2011. Expert review on on-grid safety of the first group of underground generating units was finished in November.

● Navigation Management

In 2011, the fast check and repair equipment for the Three Gorges ship lock has been improved. Data statistics and analysis had been strengthened and the "safe, efficient and smooth" target has been met. There were 10347 times of gate operation in the whole year, up by 10% compared with that of 2010. A total of 100.33 million t goods had passed the gate, up by 27.3% compared with that of 2010.

● Construction

In 2011, the principal project of the Three Gorges Project was the construction of underground power station and shiplift extension project, the installation of 4 underground generating units was finished and transferred to the Three Gorges Power Station for operation. The extension project for shiplift mainly included Stage I concrete construction and embedded parts and so on. In 2011, the assessment of installation quality of 931 units of the civil engineering and metal structure of Three Gorges Reservoir underground power station and shiplift was finished with qualification rate at 100%, 96.3% of them at good level without any quality accident. Among them, there were 22300 m^3 pouring of concrete with installation of 23770 t weight of generating units in the underground power station. The expansion project of shiplift had finished pouring of 63000 m^3 of concrete and bury and installation of 3358 t of metal, mechanic and electricity components.

● Check and acceptance

The Ministry of Water Resources organized relevant experts and water department at all levels conducted site inspection on the construction and implementation of water & soil conservation facilities in the construction sites of the Three Gorges Project in November of 2011. The water and soil conservation facilities in the construction area of the Three Gorges Project had passed the post-construction check and acceptance organized by Ministry of Water Resources on November 14.

In 2011, the Three Gorges Project had safe and sound operation with smooth progress of the construction, evident achievements in administration of the project management area, transportation and eco environment as well as increasing improvement of regional environmental quality. With scientific planning and development, the construction, operation and management of the hydro project has made great efforts in beautifying eco environment of the administrative area of the Project when developing and utilizing hydropower resources and achieved win-win situation of resources development and improvement of eco environment.

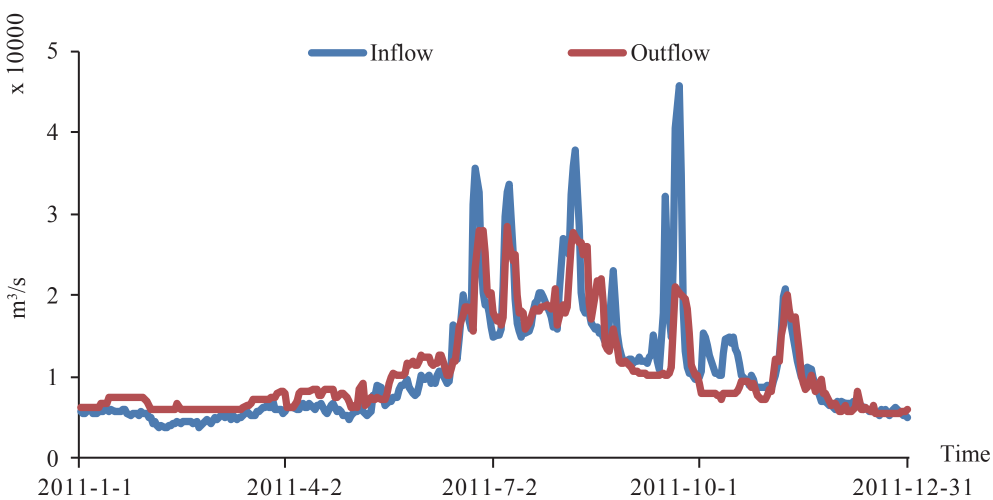


Figure 1–1 Inflow and outflow of the Three Gorges Reservoir in 2011

Chapter 2
Economic and Social Development

In 2011, the total registered population in the Three Gorges Reservoir areas was 16.7277 million, up by 0.7% compared with that of 2010. Among them, 11.4751 million were farmers, down by 5.3% compared with that of 2010. A total of 5.2526 million were urban residents, up by 17.3%, accounting for 31.4% of the total population.

The total GDP of the Three Gorges Reservoir area was 444.466 billion yuan, up by 16.8% compared with that of last year based on comparable price. Among them, the GDP of Chongqing area was 400.001 billion yuan, up by 16.9%; GDP of Hubei area was 44.465 billion yuan, up by 16.0% compared with that of 2010. The primary, secondary and tertiary industries had achieved the added value of 48.664 billion yuan, 263.659 billion yuan and 132.148 billion yuan respectively, up by 5.3%, 21.7% and 11.6% respectively compared with that of 2010. Among them, the industrial added value was 200.963 billion yuan, up by 21.8%. The proportion of the added value of primary, secondary and tertiary industry was 11.0 : 59.3 : 29.7.

The total local financial revenue of the Three Gorges Reservoir area at district and county level was 47.439 billion yuan, up by 52.1% compared with that of 2010. Among them, the local financial revenue of Chongqing area was 44.919 billion yuan, up by 52.8% compared with that of 2010; the financial revenue of Hubei area was 2.520 billion yuan, up by 41.4% compared with that of 2010. The total local financial expenditure at district and county level reached 92.503 billion yuan, up by 35.7% compared with that of 2010. Among them, the local financial expenditure of Chongqing area was 84.905 billion yuan, up by 37.9% compared with that of 2010. The local financial expenditure of Hubei area was 7.598 billion yuan, up by 15.0%.

The total grain yield of the Three Gorges Reservoir area was 6.1572 million t, down by 1.9% compared with that of 2010. Among them, the grain yield was 5.6004 million t for Chongqing area and 556800 t for Hubei area, down by 1.0% and 3.7% respectively compared with that of 2010. The total yield of oil crops in the Three Gorges Reservoir area was 256200 t, up by 2.7%

Table 2–1 Main economic indicators of the Three Gorges Project area in 2011

Indicator	Three Gorges Reservoir		Chongqing area		Hubei area	
	Amount	Increase	Amount	Increase	Amount	Increase
Local GDP (100 million yuan)	4444.66	16.8%	4000.01	16.9%	444.65	16.0%
# Industry (100 million yuan)	2009.63	21.8%	1980.15	21.9%	29.48	17.7%
Local financial revenue (100 million yuan)	474.39	52.1%	449.19	52.8%	25.20	41.4%
Local financial expenditure (100 million yuan)	925.03	35.7%	849.05	37.9%	75.98	15.0%
Per capita net income of farmers (yuan)	6427	23.4%	6547	23.9%	5465	18.6%
Per capita disposable income of urban residents (yuan)	18694	16.7%	18939	16.7%	14668	16.3%
Total investment in fixed assets (100 million yuan)	3422.75	29.6%	3123.15	29.8%	299.60	28.1%
Total retail sales of consumer goods (100 million yuan)	1236.19	22.0%	1114.19	23.2%	122.00	12.4%

compared with that of 2010. Among them, 190100 t were in Chongqing area and 66100 t in Hubei area, up by 3.0% and 1.0% respectively compared with that of 2010. The total meat output in the Three Gorges Reservoir area was 1.1428 million t, up by 3.5%. Among them, 899000 t were in the Chongqing area and 243800 t in Hubei area, up by 2.0% and 5.3% compared with that of 2010.

The per capita disposable income of the residents in cities and towns of the Three Gorges Project area was 18694 yuan, up by 16.7%. The per capita net income of farmers was 6427 yuan, up by 23.4% compared with that of 2010. Among them, the per capita disposable income of the residents in cities and towns of Chongqing area was 18939 yuan, up by 2710 yuan and 16.7% compared with that of 2010, 1311 yuan less than that of the residents in cities and towns of Chongqing Municipality. The per capita net income of farmers was 6547 yuan, up by 1263 yuan and 23.9% compared with that of 2010, 67 yuan more than that of the farmers in Chongqing Municipality. The per capita disposable income of the residents in cities and towns of Hubei area was 14668 yuan, up by 2060 yuan and 16.3% compared with that of 2010, but 3706 yuan less than that of the residents in cities and towns of Hubei Province. The per capita net income of farmers was 5465 yuan, up by 857 yuan and 18.6% compared with that of 2010, but 1433 yuan less than that of the farmers in Hubei Province.

The total investment in fixed assets of the Three Gorges Reservoir area was 342.275 billion yuan, up by 29.6% compared with that of 2010. Among them, the total investment in fixed assets of Chongqing area was 312.315 billion yuan, up by 29.8% compared with that of 2010. The total investment in fixed assets of Hubei area was 29.960 billion yuan, up by 28.1% compared with that of 2010. The total retail sales of consumer goods of the Three Gorges Reservoir area was 123.619 billion yuan, up by 22.0% compared with that of 2010. Among them, 111.419 billion yuan occurred in Chongqing area, up by 23.2%; and 12.200 billion yuan occurred in Hubei area, up by 12.4% compared with that of 2010.

Chapter 3
State of Natural Ecological Environment

3.1 Climate

In 2011, the annual average air temperature of the Three Gorges Project area was higher than the historical average, but annual average precipitation was less than the historical average. The air temperature was low in early winter but high in late winter with warm spring and hot autumn. The precipitation intensity was big in the summer with more rains in the autumn. The annual average evaporation was similar to the historical average. The annual average relative humidity was obviously lower than that of normal years. The annual average wind speed was less than the historical average. The annual average amount of foggy days was abnormally less than that of normal years. The main meteorological disasters in the Three Gorges Project area included freeze, snow disaster, drought, strong precipitation, gale, hail and high temperature and so on.

Table 3–1 Monitoring results of meteorological elements of each station in the Three Gorges Project areas in 2011

Station	Average temperature (℃)	Precipitation (mm)	Evaporation (mm)	Relative humidity (%)	Average wind speed (m/s)	Sunshine hours (h)	Foggy days (d)	Thunder storm days (d)
Chongqing	18.8	839.9	1342.3	70	1.5	958.9	11	24
Changshou	18.1	916.9	1049.2	75	1.3	1308.5	24	23
Fuling	18.6	888.8	1405.0	72	0.9	1222.3	20	21
Fengdu	18.8	1022.4	1372.5	73	1.5	1537.6	17	25
Zhongxian	18.0	1061.7	1189.0	81	1.2	1199.6	8	24
Wanzhou	18.6	1317.2	1487.1	73	1.2	1295.8	11	27
Yunyang	18.2	1446.3	1396.7	71	1.1	1387.2	27	26
Fengjie	18.3	1176.1	1309.7	66	1.6	1460.7	8	24
Wushan	18.5	1110.8	1358.2	62	0.6	1479.9	2	22
Badong	17.1	1061.1	1627.3	68	1.8	1474.9	23	27
Zigui	16.3	972.6	761.0	73	1.0	1518.1	0	30
Bahekou	16.8	910.9	1185.5	71	1.3	1197.5	0	20
Yichang	17.1	1024.1	1414.8	73	1.2	1316.3	21	25

In 2011, the annual average air temperature of the Three Gorges Reservoir area was 18.0℃, 0.3℃ higher than that of normal years, the 11th consecutive year with relatively high temperature since 2001. The annual average temperature of the Three Gorges Reservoir area has been rising over the past 50 years, similar to the change trend of annual average temperature of Southwest China. Compared with that of normal years, the annual average temperature was higher than the historical average except Zhongxian and Badong. In all four seasons, the average temperature in the winter was 7.5℃, 0.4℃ lower than that of same period of normal years. The average temperature in the spring was 17.9℃, 0.4℃ higher than that of same period of normal years.

The average temperature in the summer was 27.6℃, 0.5℃ higher than that of same period of normal years. The average temperature in the autumn was 19.3℃, 0.9℃ higher than that of same period of normal years. In all 12 months, January had the lowest average air temperature at 4.3℃. July had the highest average temperature at 28.2℃. The difference between the maximum monthly average temperature and minimum monthly average temperature was 23.9℃.

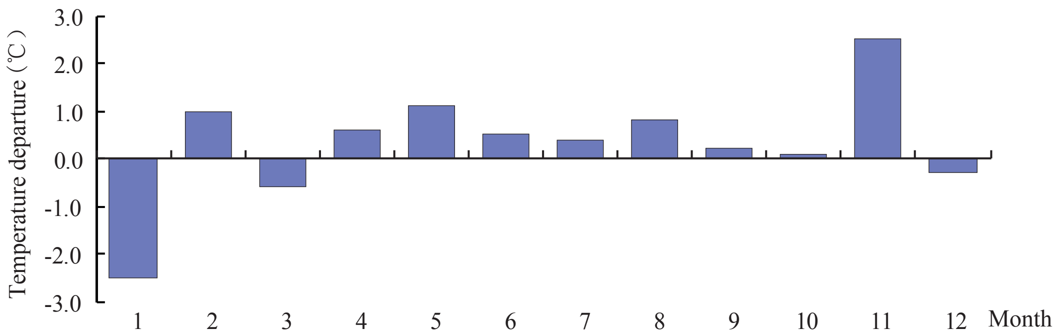


Figure 3–1 Departure of monthly average temperature of the Three Gorges Project area in 2011

In 2011, the average precipitation of the Three Gorges Reservoir area was 1070.0 mm, 4.7% less than the historical average (1122.5 mm), but 8.2% more than that of 2010. The annual precipitation of the Three Gorges Reservoir area was 839.9~1446.3 mm, showing big spatial difference, more in the central part but less in the two ends with the maximum in Yunyang and minimum in Chongqing. Compared with the historical average, the Yunyang had 28% more precipitation; Chongqing, Changshou and Fuling had 21%~24% less precipitation; Zhongxian and Yichang had 10% and 13% less precipitation. The precipitation of other monitoring stations was similar to the historical average. In four seasons, the average precipitation in autumn was 359.5 mm, 29% more than that of historical average. Other three seasons had less precipitation compared with that of normal years. Among them, the precipitation was 41.1 mm in winter, 253.5 mm in the spring and 410.5 mm in the summer, down by 27%, 18% and 15% respectively compared with the historical average. In all 12 months, the Three Gorges Reservoir area had abnormally more precipitation in November, nearly 1.3 times more than that of same month of normal years, 15%~40% more in March, October and December and 20%~40% less in January, February, July, August and September; same precipitation in the rest months.

In 2011, the annual average relatively humidity of the Three Gorges Reservoir area was 71%, obviously lower than that (77%) of the historical average. The annual average relatively humidity of all districts and counties was 62%~81% with the minimum in Wushan and maximum in Zhongxian. The annual average relatively humidity of Zhongxian and Zigui was similar to or slightly higher than that of normal years, while the rest districts and counties had lower value. Among them, Changshou, Fengdu, Fuling, Chongqing and Wanzhou had evident reduction of its annual average relatively humidity, 9~10% less than the historical average. The relative humidity was 71% in winter, 70% in spring, 70% in summer and 78% in autumn. Among them, the annual average relatively humidity in winter, spring and summer had evident drop compared with the historical average, while the annual average relatively humidity in autumn was similar to the historical average.

The annual average evaporation of the Three Gorges Project area was 1309.4 mm, more than the historical average (1225.3 mm). In all monitoring stations, the annual evaporation of Fengdu, Fengjie, Wushan and Yunyang exceeded 1300 mm. Wanzhou, Yichang and Fuling had over 1400 mm, Badong had the maximum at 1627.3mm. The annual evaporation of all counties had 100~200 mm more compared with the historical average. There was relatively big change of evaporation in four seasons. The average evaporation in winter was 128.8 mm, similar to the historical average. The average evaporation in spring was 374.4 mm, 11% more than the historical average. The average evaporation in summer was 546.6 mm, slightly less than the historical average. The average evaporation in autumn was 256.1 mm, 16% less than the historical average.

The annual average wind speed of the Three Gorges Project area was 1.2 m/s, less than the historical average (1.3 m/s). The annual average wind speed of all counties exceeded 1.0 m/s except Fuling and Wushan. Badong had the maximum average wind speed at 1.8 m/s, while Wushan had the minimum at 0.5 m/s. There was no big change of average wind speed in all 12 months with the maximum 1.4 m/s in April, August and September and minimum 1.1 m/s in June, October, November and December. Compared with that of normal years, the average wind speed of all months was similar to or 0.1~0.3 m/s less compared with the historical average except in January with 0.1 m/s higher.

In 2011, there were 13 foggy days in the Three Gorges Reservoir area, 25 days less than the historical average, the least over the past 38 years. In spatial distribution, there were more foggy days in the two ends of the Three Gorges Reservoir area but less in the central part. Among them, there were 24, 23, 21 and 20 foggy days in Changshou, Badong, Yichang and Fuling respectively, but less than 20 days in other areas. The amount of foggy days was only 2 in Wushan, no foggy day was observed in Zigui. Yunyang and Yichang had similar foggy days compared with the historical average, while the rest districts and counties had at least 50% less foggy days. Among them, Changshou, Fuling, Wanzhou and Zhongxian had over 40 less foggy days. The average amount of foggy days in each season was less than the historical average. There were 5.8 foggy days in the winter, 7.7 days less than the historical average. There were 3.1 foggy days in the spring, 3.5 days less than the historical average. There were 3.1 foggy days in the summer, 3.2 days less than the historical average. There were 3.4 foggy days in the autumn, 8.0 days less than the historical average.

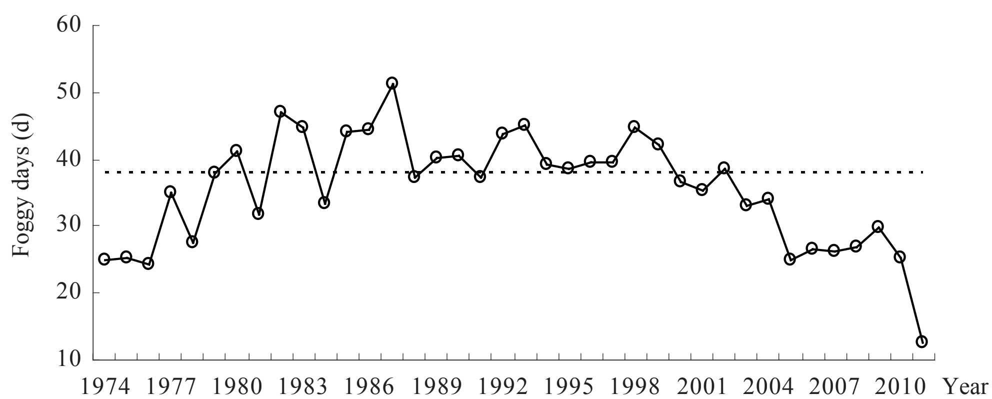


Figure 3-2 Change of annual average foggy days in the Three Gorges Project area during 1974–2011

In 2011, the main meteorological disasters in the Three Gorges Reservoir area and the neighboring area included freeze, snow disaster, drought, storm, flood, gale, hail and high temperature and so on.

Freeze and snow disaster: There were a number of rains and snow in the Three Gorges Reservoir area in the winter of 2010/2011. The air temperature of most areas in the January was obviously lower than the historical average. The average temperature of Chongqing Municipality was 0.7℃ lower than the historical average, the lowest since 2000. The air temperature of most areas of Hubei in January was 1.6~3.5℃ lower the historical average, ranking top 5 lowest temperature in the history.

There were freeze, rain and snow in the Three Gorges Reservoir area during December 14~16, 2010. The lowest temperature of most areas in mid and northern part of Hubei Province was below 0℃ except the valley areas of the Three Gorges, it was -7~-3℃ in some areas of northwestern part of Hubei. The low temperature

Snow and frost weather

and snow caused disaster and damage to 920.5 ha commercial forest and 100 ha vegetable in Chongqing, leading to over 12 million yuan direct economic loss. In Hubei Province, small amount of well-grown rape was subject to slight freeze, some open-grown vegetables and vegetables in unsealed greenhouse suffered from freeze disaster.

The air temperature of the Three Gorges Reservoir area was continuously low in January of 2011. Continuous rain, snow and freezing weather occurred in some mountainous areas and high attitude area in Chongqing Municipality, many highways in the Municipality were closed due to snow. Snow storm suddenly occurred in southeastern part of Chongqing on January 19, leading to stagnation of traffic in Qianjiang area. The low temperature rain and snow caused disaster to 1.895 million people in 22 districts and counties of Chongqing Municipality; 0.13 million ha crops, no yield of 6346.3 ha farmland, damage of 1664 houses, collapse of 243 houses, death of 33703 heads of livestock, interruption or close of many highways; damages of water and power facilities in some districts and counties. 1.04 billion yuan direct economic loss. The rape in the reservoir area in Hubei Province was subject to slight freeze. 1.50 million mu orange trees suffered from the freeze, taking up 40% of total area. 1.20 million mu tea was subject to the freeze, accounting for over 1/3 tea planting area.

Drought: From November of 2010 to May of 2011, the precipitation in Hubei Province was abnormally less. The province had continuous long spell of drought in winter and spring with wide coverage and big influence. In this period, the average precipitation in Hubei Province was 238 mm, less over 50% compared with the historical average, hitting the new low in the history.

Storm and Flood: Regions like Hubei and Chongqing had several times strong precipitation covering wide areas due to the influences of factors such as subtropical high pressure, monsoon of the South China Sea, convection activities in Qinghai-Tibet Plateau and sufficient water vapor transport since the summer of 2011, which had effectively ended previous drought, but caused flood disaster in some areas.

Areas like Beibei, Yubei, Fengdu, Changshou, Zhong xian and Dianjiang in Chongqing had heavy rains during May 21-22, causing disaster to 130000 people, emergency transfer and settlement of 490 people, damage of 2100 ha crops, over 10 million yuan direct economic loss. Meanwhile, it caused several slope failures along national highway 210 involving over 100 m^3 of rock and soil.

Some parts of Hubei Province had strong precipitation during June 17-18, leading to many landslides and slope failures of four provincial highways in Hefeng County and traffic interruption; over 30000 meters collapse of Xuan'en highway, collapse of 7000 m river embankment, 23 bridges and fall of over 40 electric posts. Many village roads in Jianshi County and Changyang County were damaged with interruption of traffic.

Shengnongjia forest area and Xingshan County in Hubei Province suffered a storm on August 22, there were 33 debris flow or collapse including the Dangyang Bridge and mouth of Qingyandong tunnel at national highway 209 in Shengnongjia forest area, leading to damage of highway and interruption of traffic.

There were several big autumn rainfalls in the Three Gorges Project area during September to October. There was obvious precipitation in northeastern part of Chongqing Municipality in the mid of September. The 24-hour accumulated rainfall in Sangping of Yunyang County reached 244 mm. Areas such as Kaixian, Yunyang, Wuxi, Fengjie, Xiushan and Tongliang had storm and flood disasters.

Gale and hail: There were much strong convection weather in the Three Gorges Reservoir area and neighboring areas. The area from Xiabao Town to Shuangyang Township in Wuxi County of Chongqing was attacked by gale and hails on April 27, 2011. The maximum instantaneous wind speed in valley reached

17 m/s, the maximum diameter of hails was 1~2 cm with depth of 1~3 cm hails on the ground. The gale and hail caused damages to over 1000 ha crops and roof tiles of rural houses in some towns and townships.

High temperature: In the summer, there were 20~40 days with high temperature (daily maximum temp ≥ 35℃) in the Three Gorges Project area and surrounding areas. There were 5~20 more high-temperature days in most areas compared with that of same period of normal years, more than 20 such days in southwestern part of Chongqing. There were 9 consecutive days with the daily maximum temperature ≥40℃ in Jiangjin, 7 days in Yunyang, the most in the history; 5 such days in Shapingba, 5 days in Kaixian, the second most in local history. The extreme maximum air temperature of each district and county of the Three Gorges Project area was 37~42℃ with the highest at 43.0℃ in Jiangjin of Chongqing Municipality.

Frequent high temperature in summer lead to poor pollination of rice, shorter filling and evident pre-mature driven by high temperature, affecting ripening rate and yield. At the same time, it led to rapid development of drought in some areas and difficulty in planting late autumn crops. High temperature and dry weather caused frequent forest fires. There were 7 forest fires in Chongqing Municipality along from July to mid August.

3.2 Terrestrial Animals

Up to the beginning of 2012, there were a total of 694 species of 336 genuses of 110 families in 30 orders of 4 classes wild terrestrial vertebrates in the Three Gorges Reservoir areas. Among them, 112 species of 74 genuses of 25 families in 8 orders were animals; 487 species of 210 genuses of 65 families in 18 orders were birds; 51 species of 35 genuses of 11 families in 2 orders were reptiles; and 44 species of 17 genuses of 9 families in 2 orders were amphibious. There were 93 species of wildlife under national key protection program, 15 species of them were under Grade I protection program and 78 species under Grade II protection program.

There was no obvious change of the total amount of population structure of terrestrial wild vertebrates. However, there was relatively big change of the population of individual species. A total of 727 grebes were found in investigation on over-winter water birds, up by 23% compared with that of 2010. There were 2995 mallard, slight drop (1.25%) compared with that of 2010, the population of large mallard community could reach several hundreds. The Three Gorges Reservoir waters become an important over-winter site for these water birds. Among them, grebes were mainly distributed in each tributary of the Yangtze River. Mallard is mainly distributed in the mainstream of the Yangtze River. In addition, the habitats of water birds such as grebes and mallard presented the trend of moving to the upper reaches, indicating relatively evident influence of water level change on these species of water birds.

No indicating species sensitive to environment change such as *Cinclus pallassi* and *Chaimarrornis leucocephalus* was observed during the investigation. Several *Chinese goshawk* (top predator) were recorded, however, the breeding nest of Chinese goshawk had not been found for the fourth consecutive year.

3.3 Rare and Unique Aquatic Animals

3.3.1 Unique fish species

Ferret–badger

Sampling using Jiang net

In 2011, a total of 120 species of fish were observed at the Yibin-Yichang river section, 25 species of them were unique fish species in the upper reaches of the Yangtze River and 4 were alien species. There was no obvious change of the amount of unique fish species in upper reach sections such as Yibin and Hejiang after impoundment compared with that before the impoundment of the Three Gorges Reservoir. The amount of unique fish species in the Three Gorges Reservoir waters had an evident decrease.

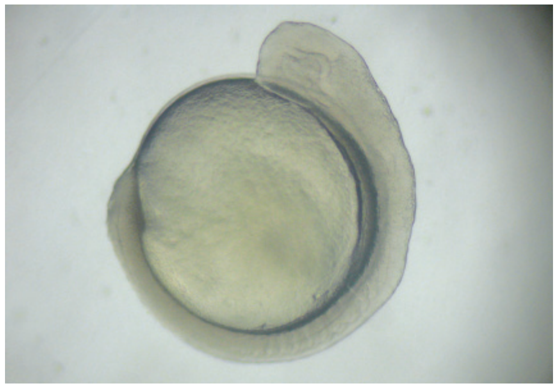
44807 tails of fish with total weight of 2185.49 kg were captured in the investigation. Among them, 5745 tails with 323.38 kg were unique fish species, taking up 14.8% of the total weight and 12.8% of total tails. Both percentage by weight and percentage by tails of unique fish species had some increase compared with that of last year. There was still some scale population of the unique fish species in the Yibin section and Hejiang section upstream of the reservoir and Mudong section at the tail of the reservoir after the impoundment of the Three Gorges Reservoir. However, the amount of the unique fish species is very small in Wanzhou section in the central part of the reservoir, Zigui section in the head as well as Yichang section downstream the Three Gorges Dam.

Trial on artificial breeding of the three unique fish species in upper reach of the Yangtze River such as *parabotia bimaculata*, *Hemiculter sauvagei*, and *Megalobrama pellegrini* was carried out. No fertilized eggs were obtained for *parabotia bimaculata*. However, 361,000 fries were obtained for *Hemiculter sauvagei* and *Megalobrama pellegrini*.

3.3.2 Rare aquatic animals

In 2011, sonar detection showed that spawning Chinese sturgeon (*Acipenser sinensis*) was mainly distributed in the river section from Daliang Power Station of Gezhou Dam to Yanshou Dam. It is estimated based on sonar detection data that the spawning stock of Chinese sturgeon was 209 tails before spawning and 137 tails after spawning with some increase of pre-spawning population compared with that of 2010. The analysis based on historical data showed that the spawning population of Chinese sturgeon is still at relatively low level.

Genetic analysis shows that average observed heterozygosity (Ho) of juvenile Chinese sturgeons at the estuary of the Yangtze River was 0.967, and their average expected heterozygosity (He) was 0.763, the average Hardy-Weinberg genetic deviation index was 0.287. There was no obvious difference of the number of alleles and effective number of alleles of each site of juvenile Chinese sturgeon community of 2011 compared with that of 2007-2010.



Embryo from pelagic eggs
(the stage where eye base develops)

It is estimated by acoustic detection data on mid and lower reaches and lakes of the Yangtze River that the population of Yangtze finless porpoise was about 1000 heads in the mainstream of the Yangtze River, they had many separate habitats. Among them, there were about 450 heads in the Poyang Lake, about 150 heads in the Dongting Lake. The habitat of finless porpoise is declining with continuous reduction of its population due to the influence of drought, very low water level and sand mining. No white-flag dolphin (*Lipotes vexillifer*) was found in the investigation of this year.

3.4 Agricultural Ecology

3.4.1 Agricultural Ecology

In 2011, the total area of agricultural land in the Three Gorges Project area was 380864 ha, 153548 ha of them were dry land, 104380 ha were paddy field, 71880 ha were orange orchard, 13022 ha were tea growing area, 2290 ha were for traditional Chinese herb medicines and the rest 35744 ha for others. In the agricultural land mix, 67.7% were arable land. Among them, dry land took up 40.3%, paddy field accounted for 27.4% and orchards took up 32.3%. Among the orchard area, 18.9% was for orange, 3.4% for tea, 0.6% for traditional Chinese medicine and 9.4% for others.

The area of triple cropping, double cropping and one cropping in dry farmland accounted for 39.3%, 43.3%

and 17.4% respectively. Compared with reduction of the proportion of triple cropping but some increase of double cropping and one cropping compared with that of last year. Among paddy field, the area of triple cropping, double cropping and one cropping in dry farmland accounted for 11.2%, 55.3% and 33.5% respectively. There was certain rise of the percentage of double cropping but some drop of the percentage of triple cropping and once cropping compared with that of last year.

In the arable land mix (excluding paddy field), the proportion of farmland with slope less than 10°, 10°~15°, 15°~25° and bigger than 25° accounted for 17.7%, 29.4%, 35.1% and 17.8% respectively of the total. In the altitude mix, the land at less than 500 m, 500~800 m, 800~1200 m and bigger than 1200 m altitude took up 53.6%, 31.8%, 11.8% and 2.8% respectively. A total of 8323 ha slope land had been turned into terraced field, and 11247 ha farmland had been restored to forest or grassland in the project area.

Table 3–2 Major crop disease and insect pests of the Three Gorges Project area in 2011

Type of plant disease and insect pests	Area affected (hectare-times)	Area controlled (hectare-times)	Loss saved (t)	Actual loss (t)	Economic loss (10,000yuan)
Rice plant hopper	49520	50391	19832	3680	820.0
Rice leaf folder	31785	30444	11788	2544	565.3
Rice sheath blight	26184	24201	6142	1448	284.0
Rice blast	10328	12612	2383	474	100.3
Wheat stripe rust	11137	11076	2760	1048	186.6
Wheat scab	6870	6466	1697	528	101.3
Wheat powdery wildew	11463	10852	1366	703	138.6
Wheat sharp eyespot	10252	8705	1377	459	80.0
Wheat aphid	12393	11464	1532	291	58.8
Maize borer	36476	33984	6759	1532	372.3
Corn sheath blight	27905	24137	6275	1938	476.4
Corn leaf blight	13238	13997	1019	679	142.7
Rape sclerotinia rot	11560	6530	990	1298	516.0
Rape aphids	14121	13135	1160	523	224.6
Potato late blight	14665	14143	10168	2927	466.2
Vegetable aphid	34386	21910	20160	5823	970.3
Cabbage caterpillar & diamondback moth	39555	46467	18078	5491	1150.1
Vegetable leafminer	4648	5077	2875	1555	258.4
Vegetable mite	4293	5523	3407	1761	247.0
Vegetable downy mildew	15931	17143	9219	3407	657.1
Vegetable blight	6852	9137	5316	1883	301.0
Other vegetable disease and insect pests	14494	14254	8447	3197	524.8
Rat hazard	135514	104099	30130	18103	2267.4
Total	543571	495747	172877	61291	10909.2

The total sown area of crops was 656741 ha, grain crops took up 65.6% and commercial crops accounted for 34.4%. There was some reduction of grain crop area but some rise of the sown area of commercial crops compared with that of 2010.

3.4.2 Rural energy

In 2011, the total consumption of firewood in the Three Gorges Project area was 8.639 million t, 6.1 t per household on the average, same as that of 2010. There were 260872 rural household biogas pits with total annual output of 110.438 million m^3 biogas, 20.5 pits per 100 households with some increase compared with that of 2010. In addition, there were 3.459 million t straw & stalk, 114.398 million kW small thermal power, 21.708 million t coal from small coal pit in the energy mix of the Three Gorges Reservoir area.

3.4.3 Crop disease and insect pest

In 2011, a total of 543571 hectare-times of crops in the Three Gorges Reservoir area were subject to plant disease and insect pests. A total of 495747 hectare-times were under prevention and control of plant disease and insect pests, saving 172877 t grain with actual loss of 61291 t and 109.092 million yuan. In the crop mix, vegetables suffered the most insect pest, while winter wheat suffered from slight insect pest. Among all kinds of insect pests, vegetable downy mildew, cabbage caterpillar, diamondback moth and potato late blight had relatively big threats.

3.5 Fishery Resources and Environment

3.5.1 Fishery resources

In 2011, the total catch of natural fish in the Three Gorges Reservoir waters, downstream of the dam, Dongting Lake, Poyang Lake and estuary was 46500 t, down by 20.5% compared with that of 2010. The fry flow the "four major home fishes" at Jianli Section downstream the Three Gorges Dam was 121 million, and the fry fishing season was not obvious. There is some reduction of the catch of anchovy and eel fry at different degree in the estuary of the Yangtze River, and big increase of the catch of Chinese turtle crabs (parent crabs).

Leptobotia rubrilaris

● **Reservoir area**

In 2011, the total catch of natural fish in the Three Gorges Reservoir waters was 4570 t. It was estimated based on the composition of the catch that there were 1020 t bronze gudgeon, 1077 t carp, 742 t catfish, 616 t silver carp, 176 t grass carp and 118 t yellow catfish (Pelteobagrus fulvidraco).

Among the fish catch, bronze gudgeon, carp, catfish, silver carp, grass carp and yellow catfish accounted for took up 82.0% of the total weight, being major commercial fish species in the reservoir waters.

The fishery acoustic detection findings show that the average fish intensity of the upstream section, Wushan section, Yunyang section and Fuling section was 93.98 tail/dam^3, 47.27 tail/dam^3, 56.56 tail/dam^3 and 202.77 tail/dam^3 respectively. There was some rise of the average fish intensity in all river sections compared with that of the same period last year.

● **Downstream section**

In 2011, the catch of natural fish in section downstream the Three Gorges Dam was 1340 t. It was estimated by the fish catch mix that the output was 485 t for carp, 189 t for the "four major home fishes", 149 t for catfish, 81 t for bream, 77 t for bronze gudgeon, 59 t for yellow catfish and 46 t for crucian.

Among the catch, carp, catfish, the "four major home fishes", bronze gudgeon, bream, yellow catfish and crucian accounted for 81.0% of the total weight, being major commercial fish species downstream the Three Gorges Dam.

● **Spawning site of the "four major home fishes"**

During May-July of 2011, the fry flow of the "four major home species" at Jianli monitoring section downstream the Dam was about 121 million tails, still in low level and not obvious. The mix of "four major home species" was dominated by silver carp and grass carp, taking up 62.7% and 36.3% respectively; while black carp and bighead carp still in small amount by taking up 1.0%.

The fish-egg flow of the "four major home species" was 332 million eggs in Yidu section with some reduction compared with that of the same period last year. The analysis based on historical data shows that the "four major home species" still maintain relatively low spawning scale at Yichang river section but with fluctuation rising trend over the past few years.

● **Dongting Lake**

In 2011, the catch of natural fish in the Dongting Lake was 18300 t. Among them, the catch was 8600 t in the east Dongting Lake, 6000 t in the south Dongting Lake and 3700 t for the west Dongting Lake, accounting for 47.0%, 32.8% and 20.2% respectively of the total.

Among the fish catch, local fish species of carp, crucian carp and catfish and the "four major home fishes" took up 65.4% of the total catch and were major commercial fish species in the Dongting Lake.

The total amount of spawned eggs of carp and crucian in the whole lake was 3.84 billion. There were 17 spawning sites for carp and crucian with total area of 119 km^2 in the lake. Among them, 5 were in the east of Dongting Lake with area of 46 km^2; 8 were in the south of the lake with area of 38 km^2; and 4 in the west with an area of 35 km^2.

There were 10 feeding ground with total area of 180 km^2 in the lake. Major fish species in these feeding grounds included carp, crucian, catfish, yellow catfish, the "four major home fishes", mandarin fish (*siniperca chuatsi*) and breams etc..

● **Poyang Lake**

In 2011, the catch of natural fish in the Poyang Lake was 22300 t. Native fish species such as carp, crucian, catfish and yellow catfish as well as the "four major home fishes" accounted for 78.0% of the total catch and are the major commercial fish species of the Poyang Lake.

The total egg amount of carp and crucian in Poyang Lake was 3.368 billion. The spawning area in the lake was 186 km^2. The fish feeding ground area was 378 km^2 mainly in the central and southern parts of the lake. The fish species in the feeding ground mainly included carp, crucian, black carp, grass carp, silver carp, bighead carp, mandarin fish, catfish and culter alburnus.

● **Estuary area**

In 2011, the catch period of monitoring ship for long-tail anchovy, parent crab and eel fry in high-water season of the estuary was longer than that of last year. The average operation days of monitoring ship were more for parent crab and eel fry but less for long-tail anchovy compared with that of last year.

The single-ship catch of long-tail anchovy was 367.9 kg for the whole high-water season. The total catch was 23.2 t, down by 31.5% and 32.4% respectively compared with that of same period last year. The average single-ship output value of the catch season was 20042 yuan, up by 16.7% compared with that of 2010; the average length and weight of long-tail anchovy was 145 mm and 13.4 g, up by 4.3% and 11.7% respectively compared with that of same period last year.

The single-ship total catch of parent crab was 742.7 kg. The total catch of the catch season was 31.2 t, up by 140.8% and 140.0% respectively compared with that of same period last year. The average shell height, width and weight of the crab was 63 mm, 68 mm and 149 g respectively, up by 3.3%, 1.5% and 15.5% compared with that of last year.

The single-ship total catch of eel fry was 18669 tails, the single-ship output value of the whole catch season was 209184 yuan, up by 45.7% and 130.3% compared with that of last year. The total catch reached 2.37 t, down by 24.3% compared with that of last year.

In 2011, the amount of released license for catch of tapertail anchovy (*Coila mystus*) and parent crab was 63 and 10 respectively, same as that of last year. The released amount of license for eel fry was 1598, down by 11 licenses compared with that of last year.

3.5.2 Fishery environment

In 2011, 7 monitoring stations (Yibin, Banan, Wanzhou, Jingzhou, Yueyang, lake mouth and estuary area) were established in the mainstream of the Yangtze River, Dongting Lake, Poyang Lake and estuary area to monitor the water quality of important fishery waters of the Yangtze River basin. The assessment of water quality complies with Fishery Water Quality Standard (GB11607-89). The unmentioned items would be assessment according to corresponding water function class specified in the Environmental Quality Standard for Surface Water (GB3838-2002). The monitoring data shows that the overall water quality of important fishery waters of the Yangtze River during the breeding, growth, and wintering period good and basically met fish growth and reproduction requirements in 2011. However, some area of waters was under pollution at certain degree.

● **The upper reach of the Yangtze River**

The main pollutants of Yibin waters were copper and total phosphorus. The going-beyond-standard rate was 100.0% in winter, breeding period and growth period. The main pollutant of Banan waters was copper with 100.0% going-beyond-standard rate in wintering, breeding and growth period. All monitoring items of waters in Wanzhou did not go beyond standard. There was no evident change of the concentration of the pollutant going beyond the standard compared with that of the same period last year.

● **The mid reach of the Yangtze River**

The main pollutant of waters in Zhicheng and Jingzhou was total phosphorus (TP). Among them, the going-beyond-standard rate of TP in Zhicheng waters was 100.0% during the breeding period. The going-beyond-standard rate of TP in Jingzhou waters was 50.0% during wintering period and 100.0% during breeding period. There was some rise of TP concentration compared with that of the same period last year. There was no obvious change of the concentration of other monitoring items.

The major pollutants in Chenglingji waters were total nitrogen (TN) and total phosphorus (TP). The going-beyond-standard rate of TN was 100.0% during wintering and breeding period and 83.3% during growth period. The going-beyond-standard rate of TP was 33.3%, 100.0% and 33.3% respectively. There was certain rise of TP concentration compared with that of 2010, but there is no obvious change of the concentrations of other monitoring items.

The major pollutants in lake mouth waters were TN and TP. TN going-beyond-standard rate was 100.0% during wintering, breeding and growth period. The TP going-beyond-standard rate was 66.7% during breeding period and 33.3% during growth period. The concentrations of TN and TP had some rise compared with that of the same period last year.

● **Spawning ground of Chinese sturgeon**

All monitoring items of the spawning waters of Chinese sturgeon in Yichang section did not exceed the standard during its breeding period, showing no obvious change compared with that of the same period last year.

● **Spawning ground of the "four major home fishes"**

The major pollutants of the spawning ground of the "four major home fishes" during the breeding period were TP and ammonia nitrogen. Among them, the going-beyond-standard rate of TP was 100.0% in waters of Zhicheng, 100.0% in Jingzhou and 83.3% in Jianli. The going-beyond-standard rate of ammonia nitrogen was 100.0% at Jianli section. The going-beyond-standard rate of TP had some rise compared with that of the same period last year.

● **Dongting Lake**

The major pollutants of waters of the Dongting Lake were TN and TP. TN going-beyond-standard rate was 100.0% during wintering, breeding and growth period. The TP going-beyond-standard rate was 100.0% during wintering and breeding period and 88.9% during the growth period. The main pollutant was still TN compared with that of the same period of last year with some rise of TP concentration.

● **Poyang Lake**

The major pollutants of waters of the Poyang Lake were TN and copper. TN going-beyond-standard rate was 100.0% during wintering period, 100.0% during breeding period and 66.7% during growth period. The copper going-beyond-standard rate was 33.3% during wintering and breeding period and 100.0% during growth period. There was no obvious change of the pollutants going-beyond standard compared with that of the same period of last year.

● **Estuary area**

The major pollutant of waters of the estuary area was TN with going-beyond-standard rate at 100.0% during the catch season of eel fry and tapertail anchovy (*Coilia mystus*). The going-beyond-standard rate of petroleum was 8.3% and 16.7% respectively. Other pollutants under monitoring program did not exceed the standard. There was no obvious change of the going-beyond-standard rate of all monitoring items compared with that of the same period last year.

3.6 Earthquake and Geological Disaster

3.6.1 Earthquake

In 2011, a total of 413 earthquakes at $M \geqslant 0.0$ were recorded from the head to central part of the Three Gorges Reservoir area, down by 97 times compared with that of 2010. Among the quakes, 321 were at $0.0 \leqslant M < 1.0$, down by 95 times and 22.8% compared with that of last year. There were 82 earthquakes at $1.0 \leqslant M < 2.0$, down by 1 quake at 1.2% compared with that of 2010. There were 10 quakes at $2.0 \leqslant M < 3.0$, down by quake at 9.1% compared with that of 2010. The relatively big earthquake occurred at M2.7 Richter Scale in Badong County of Hubei Province at 6:17 of April 16, 2011. The earthquake frequency was lower than that of last year with basically the similar intensity. In general, the quakes remained at micro-earthquake and ultra microseism level, which are mainly concentrated in the areas of Badong County-Zigui County along the Yangtze River section of Hubei Province.

3.6.2 Geological Disaster

In 2011, about 3700 monitoring workers conducted monitoring on geological disasters in the Three Gorges Project area. They had finished 183,000 times of mass monitoring for prevention and control of geological disasters and 44000 times of professional monitoring. Among them, 27000 times were GPS monitoring and 13000 times were monitoring by various kinds of monitoring holes as well as 3900 times of geological inspection. All these efforts had given early warning of geological disaster risks in time.

Monitoring staff on the scene of collapsed crags

A total of 77 collapses and landslides had evident deformation or even danger in the Three Gorges Reservoir area. Among them, there were 33 in Hubei Three Gorges Reservoir areas and 44 in Chongqing Three Gorges Reservoir areas. There were 50 landslips with the front edge elevation below 175 m, taking up 64.93% of the total amount of deformation. The amount of landslips with the front edge elevation above 175 m was 27, accounting for 35.07% of total deformation.

The deformation extent of 12 collapses and landslides reached early warning-blue warning level. Two landslides reached early warning-yellow warning level (Fengbaoling landslide group at Qixia Town in Yunyang County and Shennuxi landslide at Baolong Town in Wushan County); one collapse reached early warning-orange warning level (Collapse of the Wangxia rock at Liangping Township, Wushan County).

In 2011, the Three Gorges Project conducted the fourth 175 m trial impoundment. There was no abnormal change of the amount of geological disasters in the Three Gorges Reservoir area at high water-level operational period. The amount of deformation geological disasters in the Three Gorges Reservoir area went up by 15.58% compared with that of last year. The main triggering factors of geological disasters are rainfall, water fluctuation of water level of the reservoir, engineering activities and so on.

Table 3–3 Frequency of earthquakes from the head to central part of Three Gorges Reservoir area in 2010–2011

Year / M	2010		2011	
	Annual frequency	Average monthly frequency	Annual frequency	Average monthly frequency
0.0～0.9	416	34.67	321	26.75
1.0～1.9	83	6.92	82	6.83
2.0～2.9	11	0.92	10	0.83
3.0～3.9	0	0	0	0
4.0～4.9	0	0	0	0
Total (times)	510		413	
Max. scale	2.8		2.7	

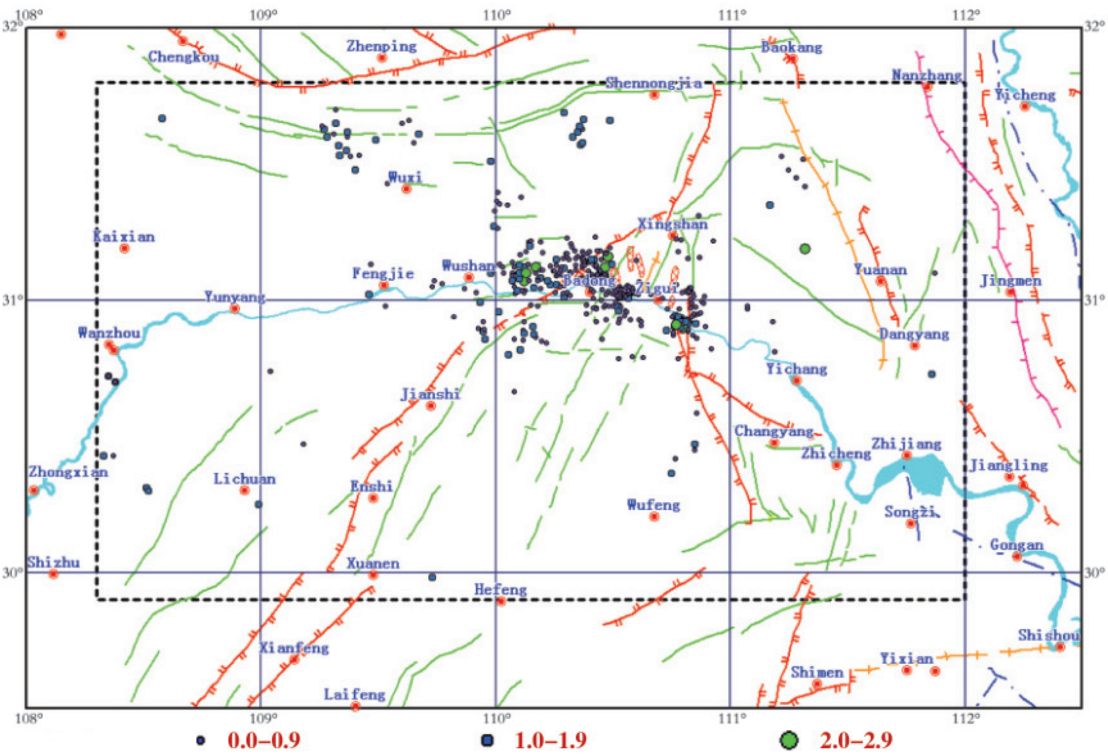


Figure 3–3 The distribution of epicenters from the head to the central part of the Three Gorges Project area in 2011

Chapter 4
Discharge of Pollution Sources

4.1 Discharge of Industrial Effluent

The wastewater discharged by the industrial sources in the Three Gorges Reservoir area amounted to 191 million t in 2011, among which 160 million t was from Chongqing region and 31 million t from Hubei region, accounting for 83.8% and 16.2% respectively of the total. There were 35,800 t of Chemical Oxygen Demand (COD) and 2,000 t of ammonia nitrogen in the said amount of industrial effluent.

Table 4–1 Discharge of industrial wastewater in the Three Gorges Reservoir area in 2011

Region		Wastewater (100 million t)	COD (10,000 t)	Ammonia nitrogen (10,000 t)
Hubei		0.31	0.67	0.02
Chongqing		1.60	2.91	0.18
Total		1.91	3.58	0.20
Sub-region	Chongqing City Proper	0.58	0.59	0.04
	Changshou District	0.29	0.28	0.02
	Fuling District	0.13	0.52	0.02
	Wanzhou District	0.16	0.46	0.07

4.2 Discharge of Urban Sewage

4.2.1 Domestic sewage

The domestic sewage discharged in the Three Gorges Reservoir area amounted to 706 million t in 2011, including 672 million t in Chongqing region and 34 million t in Hubei region, accounting for 95.2% and 4.8% of the total. There were 144,400 t COD and 25,800 t ammonia nitrogen in the total amount of domestic sewage.

4.2.2 Domestic garbage

In 2011, up to 3.2313 million t domestic garbage were generated in the 15 districts/counties in the Three Gorges Reservoir area, 2.6926 million of which was disposed, taking up 83.3%; and up to 538,700 t littered in the environment, taking up 16.7%.

4.2.3 Wastewater processed by municipal wastewater treatment plant

There were 97 municipal wastewater treatment plants in the Reservoir area, with total designed capacity at 2.827 million t per day. Those plants processed a total of 658 million t wastewater, including 646 million t domestic sewage and 12 million t industrial wastewater.

4.3 Agricultural Non-point Pollution

4.3.1 Application and loss of pesticides

Up to 701.8 t pesticides (pure volume) applied in 19 districts (counties) of the Reservoir area this year. The total amount of applied pesticides was up by 18.3% from the previous year. The organic phosphorus accounted for 46.6% of the total, the carbonates 20.7%, pyrethroid 7.3%, herbicides 16.1%, and others 9.3%. The pure volume of pesticide per hectare of farmland was 1.84 kg.

From the perspective of pesticide loss, 44.9 t

Table 4–2 Discharge of domestic sewage in the Three Gorges Reservoir area in 2011

<table>
<tr><th colspan="2">Region</th><th>Domestic sewage (100 million t)</th><th>COD (10,000 t)</th><th>Ammonia nitrogen (10,000 t)</th></tr>
<tr><td colspan="2">Hubei</td><td>0.34</td><td>0.64</td><td>0.11</td></tr>
<tr><td colspan="2">Chongqing</td><td>6.72</td><td>13.80</td><td>2.47</td></tr>
<tr><td colspan="2">Total</td><td>7.06</td><td>14.44</td><td>2.58</td></tr>
<tr><td rowspan="4">Sub-region</td><td>Chongqing City Proper</td><td>3.91</td><td>4.64</td><td>1.26</td></tr>
<tr><td>Changshou District</td><td>0.27</td><td>0.70</td><td>0.12</td></tr>
<tr><td>Fuling District</td><td>0.39</td><td>1.17</td><td>0.15</td></tr>
<tr><td>Wanzhou District</td><td>0.56</td><td>1.72</td><td>0.22</td></tr>
</table>

Table 4–3 Survey results on domestic garbage in part of the Three Gorges Reservoir area in 2011

District/county	Urban resident population (10,000)	Generated amount (10,000 t)	Disposed amount (10,000 t)	Littered (10,000 t)
Jiangjin	33.41	12.85	10.71	2.14
Chongqing city proper	530.31	203.97	169.97	33.99
Changshou	28.99	11.15	9.29	1.86
Fuling	50.04	19.25	16.04	3.21
Wulong	5.86	2.25	1.88	0.37
Fengdu	12.50	4.81	4.01	0.80
Zhongxian	14.86	5.72	4.76	0.96
Wanzhou	73.36	28.22	23.51	4.71
Yunyang	16.57	6.37	5.31	1.06
Kaixian	23.83	9.17	7.64	1.53
Fengjie	18.75	7.21	6.01	1.20
Wushan	8.63	3.32	2.77	0.55
Badong	5.29	2.71	2.27	0.44
Xingshan	3.96	2.42	2.11	0.32
Zigui	7.03	3.71	2.99	0.72
Total	833.39	323.13	269.26	53.87

Table 4–4 Statistics on urban wastewater treatment plants in the Three Gorges Reservoir area in 2011

Region	Amount of urban wastewater treatment plants	Total Designed capacity (10,000 t/d)	Wastewater processed in 2011 (100 million t)
Hubei	17	13.83	0.32
Chongqing	80	214.44	6.26
Total	97	228.27	6.58

pesticides was lost throughout the year in the reservoir area, with organic phosphorus loss accounting for 58.4% of the total loss, carbamates loss 16.0%, pyrethroid loss 5.6%, herbicides loss 12.7% and others 7.3%. The total loss of pesticides was up by 17.2%, that is, 6.6 t from the previous year. Zigui County topped the 19 districts (counties) in terms of pesticide loss, and Yunyang was second to it.

4.3.2 Application and loss of chemical fertilizers

Up to 155,000 t chemical fertilizers (pure volume) applied in the Reservoir area this year. The total amount of applied fertilizers was up by 11.5% from the previous year. Nitrogenous fertilizers accounted for 60.0% of the total, phosphate fertilizers 26.5%, and potash fertilizers 13.5%. The pure volume of chemical fertilizers per hectare of farmland was 0.41 t, same as that of last year. Wushan County topped the 16 districts (counties) in terms of fertilizers applied (pure volume) and Zigui County and Fuling District were second to it.

From the perspective of fertilizer loss, 12,300 t chemical fertilizers were lost throughout the year in the Reservoir area. The loss of nitrogenous fertilizers accounted for 75.6% of the total loss, phosphate fertilizer loss 16.3%, and potash fertilizer loss 8.1%. An average of 32.3 kg chemical fertilizers was lost per hectare of farmland in the Reservoir area. Wushan County topped the Reservoir area in terms of fertilizer loss per unit of area, and Shizhu County and Fengdu County were second to it.

4.4 Ship Pollutants

There were 8,301 registered ships in the Reservoir area in 2011. The total number of ships increased to some extent, so did their gross tonnage. No ship pollution accident was ever observed within the administrative jurisdiction of the Three Gorges Reservoir area this year.

4.4.1 Oil-contaminated waste water

In 2011, two hundred and forty nine ships were sampled in the survey on oil-contaminated waste water from the engine room of ships registered in the Reservoir area, and 82% of those ships met national discharge standards. From the perspective of ship types, all of the tugboat and non-transport ships met discharge standards when discharging water-contaminated waste water, ranking the first; 87% of the passenger boats managed to do so, ranking the second; and then 78% of the cargo boats, ranking the third. The up-to-standard rate of oil-contaminated waste water from cargo boats was still the lowest among all types of ships, although it was up by one percentage point compared with that of last year. In terms of ship power, all of the 1st ranking ships ($P>1{,}500$ kW), 4th ranking ships ($36.8\text{kW}\leqslant P<147$ kW) and 5th ranking ships ($P<36.8$ kW) met discharge standards for oil-contaminated water; up to 88% of the 2nd ranking ships ($441\text{ kW}\leqslant P<1{,}500$ kW) managed to do so, and only 59% of 3rd ranking ships ($147\text{ kW}\leqslant P<441\text{kW}$) did, the lowest of all rankings.

There were 7,620 ships discharging oil-contaminated waste water in the Reservoir area this year. The discharged oil-contaminated waste water amounted to 495,900 t, 470,800 t of them was treated, accounting for 95%. Up to 400,500 t already processed oil-contaminated waste water met discharge standards, taking up 85%. The amount of oil-contaminated waste water was up by 14,600 t from a year earlier, yet still 95% was treafed. The up-to-standard rate of treafed oil-contaminated waste water was up by one percentage point. Among all types of ships, cargo boats discharged the most oil-contaminated waste water, followed by passenger boats, and then non-transport boats, and then tugboats, with the amount being 231,100 t, 173,000 t, 77,300 t and 14,500 t respectively, accounting for 46.6%, 34.9%, 15.6% and 2.9% respectively.

Among the discharged oil-contaminated waste water, the amounted of discharged petroleum was 45.25 t, up by 4.07 t compared with that of last year. Of all types of ships, passenger boats discharged the most petroleum, which was 22.51 t (53.3%); followed by cargo boats, 17.45 t (41.3%); then by non-transport ships, 2.13 t (5.0%); and then by tugboats, 0.16 t (0.4%).

4.4.2 Ship sewage

Fifty ships were sampled in the survey on sewage from registered ships in the project area this year. Twenty-two out of them treated sewage before discharging it into the environment. Ninety-five percent of the said 22 ships met discharge standards for suspended solids, 86% met discharge standards for Biochemical oxygen demand, 77% met discharge standards for chemical oxygen demand, 64% met discharge standards for total nitrogen, and 68% met discharge standards for coliform. Only one ship met discharge standards for total phosphorus. Twenty-eight ships dumped sewage directly into the environment without Treatment. Only one ship met discharge standards for suspended solids, eight ships met discharge standards for chemical oxygen demand,

Table 4–5 Discharge of oil–contaminated waste water from the ships in the Three Gorges Project area in 2011

Ship		Oil-contaminated waste water						Petroleum	
Type	Amount	Generated amount (10,000t)	Percent (%)	Treatment amount (10,000 t)	Treatment rate (%)	Meeting standard amount (10,000 t)	Meeting standard rate (%)	Discharged (t)	Percent (%)
Passenger	2387	17.30	34.9	16.78	97	15.54	93	22.51	53.3
Cargo	3424	23.11	46.6	21.22	92	16.27	77	17.45	41.3
Tugboat	188	1.45	2.9	1.45	100	1.35	93	0.16	0.4
Non-transport	1621	7.73	15.6	7.63	99	6.89	90	2.13	5.0
Total	7620	49.59	100	47.08	95	40.05	85	45.25	100

and two ships met discharge standards for biological oxygen demand. The above said eleven ships failed to meet discharge standards for any other monitoring items, and the rest of those ships failed to meet any discharge standards at all.

It was estimated that ships in the Reservoir area discharged about 3.889 million t sewage, down by 116,000 t than that of last year. The estimate was based on the amount of ships in the Reservoir area, sewage discharge amount, passenger load, crew size, shipping hours, and percentage of ships with different tonnages. Among them, passenger boats discharged 2.775 million t of sewage, accounting for 71.4% of the total; the percentage went down compared with last year, which was attributed to smaller passenger load. The cargo boats discharged 728,000 t sewage, accounting for 18.7%. Other types of ships discharged 386,000 t sewage, taking up 9.9%.

The pollutants in descending order in the sewage were chemical oxygen demand (697.3 t), suspended solids (691.4 t), total nitrogen (329.4 t), biochemical oxygen demand (291.3 t) and total phosphorus (49.7 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 Reservoir area in 2011. Based on the survey, the garbage generated by all of the ships registered in the Reservoir area was estimated to around 49,000 t. Among them, maritime authorities collected 8,821.7 t garbage from ships, accounting 18% of the total.

Chapter 5
Status of Water Environment Quality

The monitoring items of the water environment quality in the Three Gorges Reservoir area in 2011 included the streamflow and water quality of the mainstream and tributaries of Yangtze River, and the general nutrition status and water blooms of primary tributaries. The evaluation of overall water quality and nutrition status complied with Measures on the Evaluation of Environment Quality of Surface Water (trial) (*Huanban No. [2011]22*).

5.1 Hydrology

Five hydrological monitoring sections were established in 2011 for the mainstream of the Yangtze River in the Reservoir area, they 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 flow of the mainstream in the Reservoir area ranged between 2,980 m^3/s and 22,000 m^3/s with the average flow rate ranged between 0.06 m/s and 2.30 m/s. Affected by the impoundment, the flow rate of the reaches between Tuokou Section and Three Gorges Dam was much smaller than that of the upper reach of the mainstream. The average flow rate was 1.30m/s (Zhutuo), 1.28m/s (Cuntan), 0.52m/s (Qingxichang), 0.26m/s (Tuokou), and 0.18m/s (Guandukou) respectively. The maximum flow rate was 2.00m/s (Zhutuo), 2.30m/s (Cuntan), 1.37m/s (Qingxichang), 0.61m/s (Tuokou), and 0.48m/s (Guandukou) respectively.

5.2 Water Quality

There were six sections monitored for water quality of the mainstream of Yangtze River in the Reservoir area this year, that is, 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 Peishi Section in Wushan County. 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. There were 77 sections monitored for the nutrition status of the 38 primary tributaries affected by the impact of backwater of mainstream, and for the nutrition status of waters at the bay close to the Dam in the upstream.

The monitoring results indicated that the mainstream of Yangtze River enjoyed good water quality at large, Jialing River recorded excellent water quality, and excessive total phosphorus was observed in the Wujiang River.

5.2.1 Water quality of the mainstream

The overall water quality of the six monitored sections in the mainstream of Yangtze River met Grade III national standards this year. According to the monthly data, Shaiwangba Section met Grade IV national

Table 5–1 Water quality of monitored sections in the mainstream of Yangtze River in the Three Gorges Reservoir area in 2011

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

standards in May, and Peishi Section met Grade IV national standards in May and June. Both sections were at or superior to Grade III national standards during the rest of the year. The primary pollutant was total phosphorus.

5.2.2 Water quality of tributary rivers

The overall water quality of Jinzi Section and Beiwenquan Section of Jialing River met Grade II national standards this year. The overall water quality of Wanmu Section and Luoying Section of Wujiang River was worse than Grade V national standards. The primary pollutant was total phosphorus. According to monthly data, Jinzi Section and Beiwenquan Section met Grade II national standards across the year; water quality of Wanmu Section was worse than Grade V national standards during all months; Luoying Section met Grade V national standards in July, Grade IV in October, Grade III in November and December, and worse than Grade V during the rest months.

Table 5–2 Water quality of monitored sections of Jialing River and Wujiang River in the Three Gorges Reservoir area in 2011

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

5.3 Nutrition and Water Blooms of Primary Tributaries

5.3.1 Nutrition

Five indicators including chlorophyll-a, total phosphorus, total nitrogen, permanganate index, and clarity are employed to estimate the general nutrition indexes and evaluate general nutrition status of tributary waters. The monitoring data showed that the nutrition status of 38 primary tributaries in the Reservoir area was the same as last year.

According to monthly data, 20.8%~39.0% of the 77 monitored sections were in eutrophication state, 58.4%~77.9% in mesotrophic state, and 0.0%~5.2% in oligotrophic state. Among them, 25.0%~52.5% of the sections in backwater reaches were in eutrophication state, so were 13.5%~24.3% of the sections in non-backwater reaches. Eutrophication was more serious in backwater reaches than in non-backwater reaches. The year-on-year percentage of sections in backwater reaches that were subject to eutrophication was down by 9.1 percentage points in March, 26.7 percentage points in August, and 5.0 percentage points in September; up by 2.1 percentage points in April, 5.8 percentage points in May, 6.2 percentage points in June, and 19.1 percentage points in July; and the same in October.

Water sampling (Shennong Creek)

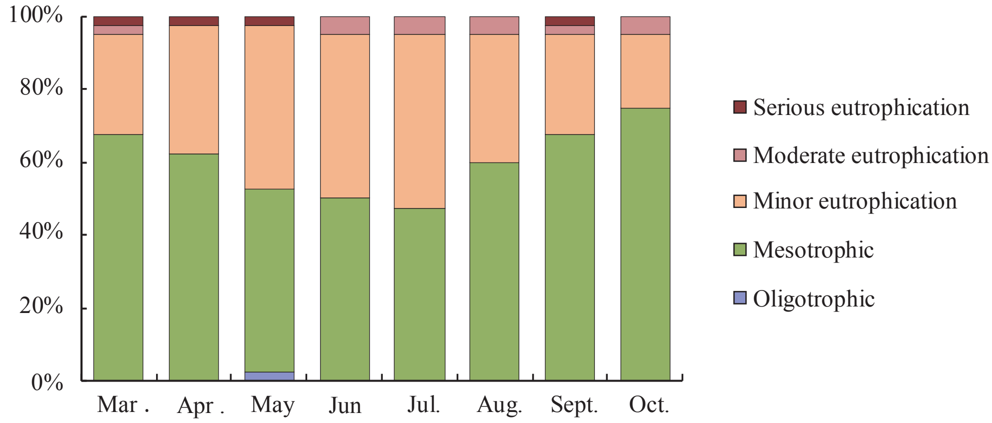


Figure 5–1 Nutrition status of backwater reaches of primary tributary rivers of Yangtze River in the Three Gorges Reservoir area between March and October 2011

5.3.2 Water blooms

In 2011, water blooms were observed in backwater reaches of the primary tributary rivers of Yangtze River in the Reservoir area, including Xiangxi River, Chixi River, Tongzhuang River, Caotang River, Meixi River, Changtan River, Modao Stream, Xiaojiang River, Ruxi River, Longhe River, Huangjin River, Dongxi River, Zhenxi River, Quxi River, and Chixi River. The dominant algae species were *Cyclotella* of *Bacillariophyta*, *Peridinaceae* of *Pyrrophyta*, *Ulothrix* of *Chlorophyta*, *Aphanizomenon flos-aquae* of *Cyanophyta*, and *Cryptomonas* of *Cryptophyta*. Water bloom outbreaks mostly occurred in the spring and autumn, with obvious changes with shift of seasons. The dominant algae species in the spring were *Cyclotella* of *Bacillariophyta* and *Peridinaceae* of *Pyrrophyta* and the dominant algae species in the autumn were *Ulothrix* of *Chlorophyta* and *Cryptomonas* of *Cryptophyta*.

Chapter 6
Status of Public Health

6.1 Basic Situation

The public health monitoring program covered 19 townships and sub-districts in the city proper, Fengdu County, Wanzhou District, and Fengjie County of Chongqing Municipality, as well as Yichang City of Hubei Province. A total of 729,088 local residents were monitored throughout the year, up by 7,389 ones from last year. Among them, 374,440 were male and 354,648 female with gender ratio of 1.06:1; 399,035 were urban residents and 330,053 rural residents.

6.2 Life Statistics

6.2.1 Birth and death

A total of 5,502 babies were born in 2011 in the monitoring sites distributed in the city proper, Fengdu County, Wanzhou District, and Fengjie County of Chongqing Municipality, as well as Yichang City of Hubei Province, 2,919 of them were male and 2,583 female with gender ratio at 1.13:1. The birth rate was 7.55‰, down by 6.44% compared with 2010. A total of 4,172 people died with mortality of 5.72‰, down by 1.21% compared with last year; male death rate was 6.62‰ and female 4.77‰.

The birth rate of the monitoring sites in city proper, Fengdu County, Wanzhou District, and Fengjie County of Chongqing Municipality and Yichang City was 7.89‰, 9.87‰, 4.86‰, 10.71‰ and 5.84‰, and death rate at 5.71‰, 6.42‰, 5.09‰, 5.01‰ and 7.51‰ respectively. Compared with the previous year, the birth rate of Chongqing city proper and Fengjie County was up by 15.86% and 12.62% respectively, and that of Fengdu County, Wanzhou District, and Yichang City was down by 12.89%, 23.94% and 18.55% respectively; the death rate of Chongqing city proper, Fengjie County, and Yichang City went up by 8.97%, 31.84% and 9.00% respectively, and that of Fengdu County and Wanzhou District was down by 0.93% and 20.22%.

There were 43 reported infant deaths in the monitoring sites, 29 male and 14 female. The infant death rate was 7.82‰, up by 51.84% 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 of the Three Gorges Reservoir area in 2011 were circulatory system diseases, malignant tumors, respiratory system diseases, injury and poisoning, and digestive system diseases, with death rate at 195.18/100,000, 158.14/100,000, 85.17/100,000, 47.87/100,000 and 16.05/100,000 respectively. The percentage of death toll caused by each of the above five major diseases against the total deaths was 34.11%, 27.64%, 14.88%, 8.37% and 2.80% respectively, totaling 87.8%.

The ranking of the top five killer diseases remained unchanged and there was little change in death cause structure compared with 2010. Among them, mortality of malignant tumors and respiratory system diseases went up by 1.99% and 8.03%, and that of circulatory system diseases, injury and poisoning, and digestive system diseases went down by 8.30%, 5.36% and 33.04% respectively. Gender analysis showed that the ranking of the top five death causes for female was the same as that of the total population, while the top death cause of male was malignant tumor. 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 ranking of top five killer diseases in Chongqing city proper and Wanzhou District was the same as that of the total population, while the ranking of top four killer diseases in Fengdu County, Wanzhou District, and Yichang City was the same as the total population. The fifth top death cause was endocrine diseases, nutrition diseases, or metabolic diseases in both Fengdu County and Wanzhou District, and genitourinary diseases in Yichang City.

6.3 Monitoring of Diseases

6.3.1 Monitoring of infectious diseases

In 2011, a total of 3,277 cases of notifiable infectious diseases were reported throughout the monitoring sites with morbidity of 449.47/100,000, down by 25.35% 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 was 746.31/100,000 in the monitoring sites of Chongqing city proper, 563.46/100,000 in Yichang City, 372.33/100,000 in Fengdu County, 344.65/100,000 in Wanzhou District, and 337.26/100,000 in Fengjie County. The morbidity in the monitoring sites of Fengjie and Chongqing city proper was up by 10.06% and 9.02%, while the morbidity in the monitoring sites of Fengdu, Wanzhou, and Yichang was down by 61.24%, 31.72% and 9.35% compared with that of the previous year. There were reports of infectious diseases in each monitoring site every month but no report on outbreak of epidemic diseases. The amount of reported cases of Category B infectious diseases was the highest in May and on the lower side in November and December, and did not change much in the rest of the months. The amount of reported Category C infectious disease cases was on the higher side in May, June and December, which were mainly hand-foot-and-mouth disease, parotitis and other types of infectious diarrhea.

The monitoring sites reported 1,977 cases that fell into 13 types of Category B infectious diseases (excluding HIV), with morbidity of 271.16/100,000, down by 14.55% compared with last year. The morbidity of Category B infectious diseases was highest at 471.09/100,000 in Yichang monitoring site and lowest at 123.48/100,000 in Wanzhou monitoring site. The morbidity in Chongqing city proper rose by 5.71%, while the morbidity in Fengdu, Wanzhou, Yichang, and Fengjie went down by 41.02%, 22.25%, 4.82% and 0.52% respectively compared with that of last year. The top five Category B infectious diseases measured by morbidity were tuberculosis (107.53/100,000), viral hepatitis (95.60/100,000), dysentery (30.59/100,000), syphilis (25.51/100,000), and gonorrhea (6.17/100,000). The cases of those five diseases accounted for 97.88% of the total cases of Category B infectious diseases. Epidemic cerebrospinal meningitis was a new type of Category B infectious disease reported in the monitoring sites and no hydrophobia case reported compared with the previous year. The morbidity of hepatitis E, measles, scarlet fever, hemorrhagic fever, A(H1N1) Flu and tuberculosis was higher, and the morbidity of the rest of the Category B infectious diseases declined. The HIV-infected population was up by 93.69% from a year ago. The morbidity of water-borne infectious diseases hepatitis A (3.29/100,000), dysentery (30.59/100,000) and typhoid (0.27/100,000) that were relevant to the impoundment was still at a low level. There was no report of natural focus diseases such as insect-borne infectious diseases leptosprirosis, dengue fever, or malaria. There was one reported case of hemorrhagic fever and of Japanese encephalitis.

A total of 1,300 cases that fell into 6 types of Category C infectious diseases were reported in all monitoring sites, with morbidity at 178.30/100,000, down by 37.38% compared with last year. The morbidity of Category C infectious diseases in the monitoring site of Chongqing city proper, Wanzhou, Fengdu, Fengjie and Yichang was 294.13/100,000, 221.17/100,000, 114.96/100,000, 104.46/100,000 and 92.37/100,000 respectively. The morbidity in Fengjie and Chongqing city proper went up by 44.24% and 14.54% respectively compared with last year, while that in Fengdu, Wanzhou, and Yichang went down by 78.07%, 36.06% and 27.06%.

6.3.2 Monitoring of endemic disease

Iodine Deficiency Disorders (IDD) was monitored in the monitoring sites of Chongqing City proper, Wanzhou, Fengdu, Yichang and Fengjie in 2011. Palpation method was employed to investigate the IDD among 735 sampled children aged between 8 and 12. Twenty-eight children were diagnosed with Degree-I thyromegaly, accounting for 3.81% with slight decline compared with that of 2010; it was a small-scale epidemic. Thyromegaly morbidity in Fengdu, Wanzhou, and Yichang recorded 7.86%, 4.65% and 0.97% respectively. A total of 1,244 households were sampled for the test of edible salt, and data showed that 1,243 households took iodine added salt, taking up 99.92%, and up by 0.28 percentage point than that of last year. The iodine added salt in 1,223 households was qualified, taking up 98.39%, up by 1.41 percentage points. The consumption rate of qualified iodine-added salt was 98.31%, up by 1.68 percentage points. The iodine added salt coverage, qualification rate of iodine-added salt, and consumption rate of qualified iodine-added salt kept at fairly high levels, thanks to the efforts of Fengdu County this year in eliminating the IDD and enhancing the supervision over the salt without iodine.

Dental fluorosis was monitored this year in Fengjie County with 116 sampled children aged between 8 and 12. Forty-three cases of such disease were diagnosed, so the positive rate was 37.07%, down by 9.98% from a year ago.

6.4 Monitoring of Biological Media

6.4.1 Monitoring of rats

In 2011, the indoor rat density of the monitoring sites was 1.97% on average and outdoor rat density 1.81%, both lower than that of the previous year and lower than the 5-year (1999-2003, sic passim) average indoor and outdoor rat density (3.94%, 4.22%) before the impoundment in 2003. The rat density was higher in the autumn than in the spring, and indoor rat density was higher than outdoor rat density. Among others, indoor rat density was 1.84% and outdoor density was 1.77% in the spring, and 2.10% and 1.86% in the autumn. The indoor rat density in descending order was 4.27% in Fengdu, 2.26% in Fengjie, 2.09% in Wanzhou, 1.45% in Chongqing city proper, and zero in Yichang. The outdoor rate density in descending order was 6.39% in Fengdu, 1.94% in Wanzhou, 1.88% in Chongqing city proper, 1.19% in Fengjie, and 0.66% in Yichang.

Rattus norvegicus was the dominant indoor rat species in the year, taking up 37.50%, followed by Mus musculus, taking up 28.13%. In the field, the small insectivore (mostly Sichuan short-tail shrew) was the dominant species, accounting for 43.30%; followed by Rattus norvegicus, accounted for 21.65%; and the last was Apodemus agrarius, accounted for 4.12% and down by 10.82 percentage points compared with last year. As the host of Hantavirus and leptospira, Apodemus agrarius has been ranking the 2nd or the 3rd over the past few years, but its percentage decreased significantly in 2011.

6.4.2 Monitoring of mosquitoes

In 2011, the gross density of adult mosquitoes in livestock pens and human dwellings was 142.61/pen•artificial hour and 26.99/room•artificial hour respectively, both figures higher than that of last year but lower than the 5-year averages (198.57/ pen•artificial hour for the former and 63.97/room•artificial hour for the latter) before the impoundment in 2003. Indoor adult mosquito density in descending order at the monitoring sites was Wanzhou (101.2/room•artificial hour), Chongqing city proper (37.70/room•artificial hour), Fengjie (12.37/room•artificial hour), Fengdu (7.36/room•artificial hour), and Yichang (3.44/room• artificial hour). The adult mosquito density in livestock pens in descending order was Wanzhou (438.84/pen•artificial hour), Fengdu (137.52/pen•artificial hour), Chongqing city proper (136.97/pen•artificial hour), Yichang (100.88/pen•artificial hour), and Fengjie (61.32/pen•artificial hour). The adult mosquito density in livestock pens rose in Fengdu and Wanzhou but declined in Chongqing city proper, Fengjie, and Yichang compared with 2010; the indoor adult mosquito density rose to some extent in Wanzhou and Chongqing city proper but somewhat declined in the rest of the monitoring sites.

Mosquito density monitoring at water–level–fluctuating zone (installing mosquito killers)

The 10-day curve of indoor adult mosquito density from May to September was similar to that of the adult mosquito density in livestock pens. Chongqing city proper and Yichang were the first to observe the peak of indoor adult mosquito density in early June, and Wanzhou and Fengdu were the last, with the maximum density observed in late July. The peak of indoor adult mosquito density occurred in late June in Fengjie. As for adult mosquito density in livestock pens, the peak came first in Fengjie in early July and last in Chongqing city proper in early September, and the rest of the monitoring sites observed the peak in early August. The mosquito species analysis showed that Armigeres subalbatus was the dominant mosquito species in both human dwellings and livestock pens, accounting for 71.70% and 78.46% of the total. Culex pipiens fatigans ranked the second as indoor mosquito species, taking up 13.69%. Culex tritaeniorhynchus, Anopheles sinensis, and Culex pipiens pallens ranked the third, fourth and fifth respectively. Among the mosquito species in livestock pens, Culex tritaeniorhynchus ranked the second, and Culex pipiens fatigans, Anopheles sinensis and Culex pipiens pallens ranked the third, fourth and fifth. The percentage of the mosquito species in human dwellings went down compared with 2010, except that of Armigeres subalbatus, Culex tritaeniorhynchus and Culex pipiens pallens. For livestock pens, the percentage of Culex pipiens fatigans and Culex tritaeniorhynchus went up, that of Culex pipiens pallens and Anopheles sinensis went down slightly, and that of Armigeres subalbatus remained at the same level compared with last year.

Chapter 7
Environmental Quality of the Dam Area

7.1 Hydrology and Meteorology

7.1.1 Hydrology

In 2011, the statistical analysis of the monitoring data at Huanglingmiao Hydrological Measuring Station downstream the Three Gorges project showed that the annual average flow was 10,800 m^3/s, with maximum flow at 28,700 m^3/s on June 25 and minimum at 5,380 m^3/s on December 27. Annual average sediment discharge rate was 0.220 t/s, with average sediment concentration at 0.020 kg/m^3. The average sediment concentration peaked at 0.088 kg/m^3 on July 2, and hit the bottom at 0.001 kg/m^3 on November 23. Compared with last year, the river flow characteristics of the Three Gorges Dam area was slight declines in annual average discharge, annual average sediment discharge rate and average sediment concentration.

Table 7–1 Monthly river flow at Huanglingmiao Hydrological Measuring Station in 2011

Unit: m^3/s

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Average	6910	5850	6600	7860	9030	16200	19000	18800	12700	8280	11500	5980	10800
Max.	7980	7130	8920	9460	13600	28700	28300	27900	22200	10700	21500	9720	28700
Min.	5520	5410	5430	5810	5940	9480	14800	10600	8870	6640	6000	5380	5380

Table 7–2 Monthly sediment concentration at Huanglingmiao Hydrological Measuring Station in 2011

Unit: kg/m^3

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Average	0.002	0.003	0.003	0.004	0.004	0.025	0.051	0.048	0.007	0.007	0.005	0.003	0.020
Max.	0.003	0.003	0.005	0.005	0.006	0.083	0.088	0.087	0.010	0.011	0.019	0.004	0.088
Min.	0.002	0.003	0.002	0.003	0.002	0.004	0.026	0.010	0.0041	0.002	0.001	0.001	0.001

7.1.2 Climate characteristics

In 2011, the climate of the Three Gorges Dam area was mild with little rain. The temperature of each month was normal with precipitation on the lower side.

● **Precipitation**

The annual precipitation of the Dam area was 859.4 mm, down by 17.6% than the historical average. The precipitation was extremely uneven among the 12 months, as precipitation concentrated between May and November with maximum daily precipitation at 58.5 mm on June 14. The longest rain spell in the year lasted 10 days in October. The longest dry spell in the year was up to 18 days through January and February.

● **Temperature**

The air temperature of the Dam area averaged 16.8℃, the same as that of the average year. The extreme high temperature in the year reached 39.1℃ on July 25, while the extreme low temperature was -3.1℃ on January 2.

● **Wind speed**

The annual average wind speed of the Dam area was

1.1 m/s with the maximum at 20.6 m/s observed on July 30. Wind direction was changeable throughout the year with North as the dominant direction, taking up 12%.

Table 7–3 Meteorological indicators of the Three Project Dam area in 2011

Month		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Temperature	Temperature(℃)	2.2	7.9	10.7	17.8	22.2	25.4	27.8	26.7	21.6	17.2	14.8	6.8	16.8
	Departure (℃)	-2.8	0.1	-1.4	0.1	0.3	0	0.5	0.2	-1.4	-0.8	1.7	-0.9	-0.4
Pecipitation	Precipitation (mm)	7.9	9.7	39.8	34.4	65.2	220.5	93.5	111.7	97.4	99.9	65.8	13.6	859.4
	Departure (%)	-56.1	-77.4	-21.5	-61.8	-46.0	75.3	-45.6	-39.4	-11.1	50.0	39.7	-9.3	-17.6
Wind Speed	Average (m/s)	1.4	1.2	1.2	1.2	1.3	1.0	1.0	1.2	1.1	0.7	1.0	1.1	1.1
	Max.(m/s)	5.1	5.7	5.9	6.2	7.0	9.6	11.2	6.3	4.8	4.9	4.6	4.9	11.2
	Extreme (m/s)	8.3	7.9	10.6	10.7	10.2	14.2	20.6	9.9	8.6	8.6	7.8	8.0	20.6

7.2 Air Quality

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

In 2011, the annual average SO_2 concentration in the Dam area was 0.006 mg/m^3, meeting Grade I standard specified in the Ambient Air Quality Standard (GB3095-1996), down by 0.002 mg/m^3 compared with 2010. All of the daily average concentrations met Grade I standard. Annual average NO_2 concentration was 0.019 mg/m^3, meeting Grade I standard but up by 0.001 mg/m^3 compared with last year. The daily average NO_2 concentrations also met Grade I standard.

The annual average TSP level was 0.150 mg/m^3, meeting Grade II standard and down by 0.003 mg/m^3 compared with last year. In office and residential areas, the daily average TSP concentration met Grade I standard in 36.4% of the days throughout the year, Grade II standard in 62.2% of those days, and Grade III standard in 1.4% of those days. In the construction sites, the daily average TSP concentration met Grade I standard in 32.6% of the days throughout the year, Grade II standard in 63.2% of those days, and Grade III standard in 4.2% of those days.

Annual average SO_2 concentration was down by 25.0%, annual average TSP level down by 2.0%, and the annual average NO_2 concentration up by 5.6% compared with that of last year. In general, the ambient air quality of the Dam area has turned better.

7.3 Water Quality

A total of 13 indicators including pH value, dissolved oxygen, ammonia nitrogen, COD, permanganate index, BOD_5, volatile phenol, cyanide, arsenic, Cr^{6+}, copper, lead, and cadmium were chosen 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). Besides the above 13 indicators, anion surfactant indicator was also used to evaluate near-bank water quality.

In 2011, water quality at sections of the mainstream and near-bank waters of the Yangtze River in the Dam area met Grade II surface water quality standard throughout the year. The water quality at Taipingxi Section and Letianxi Section of the mainstream kept at Grade II standard, the same as last year. The water quality at the upstream approach channel and auxiliary dam of the near-bank waters remained at Grade II standard, and that of downstream approach channel turned better from Grade II standard to Grade I standard.

Table 7–4 Water quality of the mainstream sections of Yangtze River in the Three Gorges Dam area in 2011

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

Table 7–5 Water quality in near–bank waters of Yangtze River in the Three Gorges Dam area in 2011

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

7.4 Noise

In the office and residential areas of the Dam area, the daytime/nighttime ambient noise level averaged at 57.0 dB/45.5 dB in 2011, meeting Grade II standard of Environmental quality standard for noise (GB3096-2008). The average ambient noise level was up by 2.3 dB at daytime and down by 2.6 dB at night compared with last year. In the construction sites, the average ambient noise level was 52.5 dB in the daytime and 47.7 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 down by 1.3 dB and 2.5 dB respectively compared with that of last year. The noise level in the boundaries of the construction sites met the limit of the Emission Standard of Environment Noise for Boundary of Construction Site (GB12523-2011). The annual average traffic noise level of the Dam area was 69.0 dB, down by 0.8 dB compared with that of last year.

Chapter 8
Monitoring and Studies on Ecological Environment

8.1 Monitoring and Studies on the Ecological Environment of Wanzhou Model Zone

8.1.1 Trial of compound farming of grain crops, cash crops and fruit trees on ridges of slope cropland

The pattern of compound farming of grain crops, cash crops and fruit trees on ridges of slope farmland (Pattern I) helped to increase soil porosity and the content of silty clay soil. As a result, it retained more nutrition and effectively reduces soil erosion and rainfall runoff. Whether it was in flush period or dry period, soil water content of Pattern I was bigger than that of compound farming of grain crops, cash crops and fruit trees on non-ridge farmland (Pattern II) and the flat cultivation of grain crops and cash crops along the slope (Pattern III). Moreover, the change of soil water content of Pattern I at different depths was smaller than that of Pattern II and Pattern III.

The Monitoring results of 2011 revealed that soil water content of Pattern I 2 days, 4 days and 8 days after rainfall was higher than that of Pattern III by 9.45%, 8.01% and 12.43% and it contained more water than Pattern II by 3.84%, 4.67% and 4.25%. Compared with that of 2010, the level of various nutrients except total potassium of Pattern I has increased, which included organic matter by 2.95%, TN by 1.98%, TP by 0.94%, Kjeldahl nitrogen by 1.05% and quick-acting nitrogen by 0.92%.

As canopy width of fruit trees was growing faster and canopy closure increases, the splashes and erosion of raindrops on soil was directly reduced. Compared with that of 2010, soil erosion of Pattern I reduced by 4.96% and runoff reduced by 34.95%. In eroded soil, the level of organic matter, TN, TP, Kjeldahl nitrogen, quick-acting phosphorus and quick-acting potassium went down by 6.04%, 10.31%, 10.29%, 4.15%, 7.81% and 5.32% respectively and that of total potassium grew by 4.26%.

Monitoring of sediment erosion in ditches

With the increase of cultivation period of Pattern I and improvement of soil structure and function, loss of nutrition in eroded soil has continued to decrease. The level of TN and TP in the runoff of Pattern I was lower than that of Pattern III.

8.1.2 Trial of the Pattern of Steep Slope with Biological Fence (Fence Pattern)

In 2011, wreath goldenrod hedgerows (Fence Pattern) was built to study water retention capacity of soil. In the beginning, soil water content of the Fence Pattern was smaller than that of Pattern III. However, as soil grew drier, the difference between the two Patterns in water content got smaller and smaller. For Fence Pattern, water content in different soil layers after rainfall did not change as much as that of Pattern III, suggesting that hedgerows help to stabilize soil water content of slope cropland. The rule of soil water content distribution of Fence Pattern was as follows: soil in the hedgerows has the most moisture, followed by the downstream soil of fences. The upstream soil of fences has the least moisture. Both soil bulk density and porosity of the Fence Pattern were smaller than that of Pattern III.

Wreath goldenrod hedgerows had a strong effect on improving the organic matter in soil. The level of organic matter in soil under the Fence Pattern jumped by 43.67% compared with that of Pattern III, but the concentration was a little lower (0.99%) than that of the king grass hedgerows. Compared with the king grass hedgerows, the wreath goldenrod hedgerows did not have evident impact on the content of TN and Kjeldahl nitrogen. The level of TP and quick-acting phosphorous increased slightly and the content of total potassium and quick-acting potassium rose a bit.

The wreath goldenrod hedgerows could effectively reduce soil erosion in the slope cropland and it excelled Pattern III in reducing runoffs and soil erosion. Compared with the king grass hedgerows planted last year, the wreath goldenrod hedgerows performed better in runoff control (the runoff reduction was 2.95% more than that of the king grass hedgerows), but it was not as effective as the king grass hedgerows in curbing soil erosion. The total amount of various nutrients in the runoff sand of the Fence Pattern was much lower than that of Pattern III with organic matter lower by 26.65%, TN by 22.25%, TP by 55.49%, Kjeldahl nitrogen by 70.75%, quick-acting phosphorous by 37.15% and quick-acting potassium by 43.91% respectively. Compared with the king grass hedgerows, the wreath goldenrod hedgerows had smaller amount of organic matter, TN, TP and quick-acting phosphorous in runoff sand while the amount of total potassium, Kjeldahl nitrogen and quick-acting potassium was bigger. The runoff water sample from the wreath goldenrod hedgerows indicated lower amount of TN and TP than that of Pattern III.

8.2 Monitoring and Studies on the Ecological Environment of Zigui Model Zone

8.2.1 Monitoring and Control of Soil and Nutrient Loss in Slope Land

In 2011, Zigui Model Zone conducted monitoring on soil erosion and loss of nitrogen and phosphorus from the navel orange orchard of the slope land and slope cropland and analyzed the results of different ecological management patterns on soil erosion and nitrogen and phosphorous loss. Findings revealed that both measures applied in the navel orange orchard like the interplant of perennial forage, wreath goldenrod hedgerows and stalk & mulch covering and high fences of the slope cropland such as planting perennial forage and interplant of crops have strong effect on water and soil conservation and reduction of nitrogen and phosphorous loss in the slope land.

The 9-year continued monitoring indicated navel orange orchard applying interplant of perennial forage, wreath goldenrod hedgerows and stalk & mulching could reduce slope runoff by 12.61%, 15.18% and 25.99% respectively compared with traditional novel orange orchard. The above three measures also reduce slope sand yield by 88.64%, 78.61% and 73.91% respectively. Slope nitrogen loss went down by 51.13%, 56.43% and 47.83% and phosphorous loss was reduced by 51.34%, 30.78% and 38.44% respectively. Planting perennial forage, interplant of cedrela sinensis hedgerows and interplant of alfafa hedgerows in the slope cropland have reduced slope runoff by 42.06%, 34.36% and 25.98% respectively. These measures reduced slope sand yield by 86.76%, 86.12% and 83.96%, nitrogen loss by 71.01%, 50.90% and 41.76% and phosphorous loss by 84.30%, 67.56% and 63.97% respectively.

Monitoring of soil fertility

8.2.2 Study and Demonstration of Ecological Agriculture Model in Slope Land

A model of ecological agriculture consisting of water-level-fluctuating zone, low altitude navel orange industry zone and traditional semi-alpine agricultural zone was established according to the characteristics of the upstream areas of the Three Gorges Reservoir.

A green model of vetiver and Salix integra with no fertilizer or ploughing and flood-enduring experiment were carried out in the water-level-fluctuating zone. According to the research results, vetiver cultivated under clean condition could tolerate submergence at the depth of 173 meters, 171 meters and 169 meters. It would continue growth after water receded. Salix integra could continue growth after being submerged at 173 meters deep. Tolerant of barrenness, submergence and drought, vetiver has developed root system which may help fix slope, conserve soil and intercept pollutants. Its economic value makes it an option for ecological management in the water-level-fluctuating zone. Vetiver and Salix integra may be used to establish a vegetation filtering zone in the area.

Plant hedgerows, stalk & mulching and pollution-free technology for navel orange were experimented and demonstrated in the low altitude navel orange industrial zone. Some protective plough models including high and low ridge tillage, little ploughing and residue mulching were experimented in slope cropland. The results showed that compared with traditional navel orange orchard, navel orange orchard that applying interplant with plant hedgerows or stalk mulching could increase TN content by 32% and 68% respectively and the technologies helped raise total potassium by 6% and 11% respectively in soil layers between 0-20cm. The experiment with pollution-free technology not only reduced pesticide cost by 28% but also improved disease and pest control. The protective plough models could increase production volume and the efficiency of fertilizer, nitrogen and phosphorous. Specifically, the agronomic efficiency of nitrogen and phosphorous was raised by 6.46 kg/kg and 10.65 kg/kg respectively and P utilization efficiency was improved by 0.08 kg/kg.

8.3 Monitoring and Studies on the of Ecological Environment of the Water-level-fluctuating Zone

In 2011, investigation on soil physiochemical properties and vegetation recovery was carried out at 22 monitoring sites in the water-level-fluctuating zone of the Three Gorges Reservoir area including Banan, Changshou, Fuling, Fengdu, Zhongxian, Wanzhou, Kaixian, Yunyang, Fengjie, Zhuyi River of Fengjie, Wushan, Badong, Zigui, Lanling Creek of Zigui and Xingshan. Assessment of soil in the water-level-fluctuating zone was conducted based on the Grade I standard of Environmental Quality Standard for Soils (GB15618-1995).

8.3.1 Physiochemical Properties of Soil

In 2011, monitoring on the composition of soil particle in the water-level-fluctuating zone of the Three Gorges Reservoir area was carried out. It was found out that the soil was mainly made up of fine sand. The content of coarse sand reduced dramatically while the amount of silty soil and clay soil increased sharply. There was a big difference in soil composition in different areas.

Monitoring on the level of heavy metal in soil after water receded (in May) was conducted. The results suggested the level of heavy metal in soil after water receded went higher. Compared with 2010, the level of As, Cr, Pb, Cu, Zn, Fe and Mn posted an increase of 18.3%, 3.1%, 51.5%, 67.1%, 26.1%, 2.7% and 13.2% respectively whereas Hg and Cd dropped by 18.2% and 25.7% respectively. Of all these heavy metals, the level of Cd, Pb and Cu exceeded Grade I standard. A comparison with soil background value of the Reservoir area indicated that the level of most of the heavy metals was higher than the background value except Cr. The monitoring results before water impoundage (September) showed the level of heavy metal in soil decreased compared with the level after water receded. Only the level of Pb exceeded Grade I standard.

The monitoring of soil nutrient level showed level of nutrient in the middle section of the reservoir area (from Zhongxian to Zhuyi River of Fengjie) after water receded was higher than the level in the upstream and downstream areas. The soil nutrient level before water impoundage was lower than the level after water receded.

8.3.2 Vegetation Recovery

Investigation of plant community after water receded was performed in 2011, which covered 73 species of vascular plant of 62 genera under 30 families. Among them, oligotypic genera and monotypic genera accounted for 12.15% and 85.48% of the total. Life form was dominated by herbaceous plant with annual herbaceous and perennial herbaceous plants taking up 45.21% and 39.73% respectively. Arbor, shrub and vine only accounted for a small proportion. Before impoundment (September), the investigation discovered 71 species of vascular plants of 60 genera belonging to 30 families. The composition of species and genera was similar to that before the impoundment.

8.4 Monitoring on Groundwater Table and Soil Gleization

The monitoring on groundwater table change and the observation of gleization indicators of the soil from Shimatou to Xiaogang Farm of the Honghu Lake located at the “Four Lakes” at the middle reaches of the Yangtze River continued in 2011.

8.4.1 Monitoring of Groundwater Table

The groundwater monitoring section consisted of 10 long-term observation boreholes in 5 groups. The distances from the 5 groups of boreholes marked with the code of A, B, C, D and E to the bank of the Yangtze River was 1.5 km, 3.0 km, 5.0 km, 8.5 km and 13.0 km respectively with borehole internal diameter of 0.11 m.

The depth of boreholes of confined water was about 35 m while that of phreatic water boreholes was 5m-7m.

The monitoring results showed that annual average groundwater level of all observation boreholes lowered by 0.29 m compared with that of the previous year and the value was 0.24m lower than the average of the past decade. The annual average groundwater level of all observation boreholes tended to drop year on year and the fluctuation got smaller as the distance between the borehole and the bank of the Yangtze River increased. The phreatic surface dropped between 0.16 m and 0.37 m and the decrease of water table of confined water ranged between 0.21 m and 0.55 m. The fluctuation of phreatic water surface was bigger than that of the water table of confined groundwater.

Monthly average water table reflected the development of water table throughout the year. In 2011, the maximum average monthly water table appeared from June to August and June had the most records. The minimum monthly water table on average was found in March and April while in the past years January and February usually had the minimum monthly average water table. In terms of the whole year, water table continued to drop from January to April and it started to rise from May, which was 2 months later than usual. High water level lasted from May to September, which was 2 months less than 2010. The water table began to plummet from October.

In 2011, water table rose late and dropped early and the yearly average level was much lower than usual. This might be connected with seasonal drought in the year.

8.4.2 Monitoring on Indicators of Soil Gleization

Monitoring on soil gleization was conducted in summer and winter respectively in 2011 and the number of monitoring sections increased by 6 compared with that of 2010. Monitoring indicators included soil moisture, pH, oxidation reduction potential, total amount of reduction material, the level of active reduction material and ferrous iron.

Monitoring results revealed that in 2011, the total amount of reduction material on average declined by 0.41 cmol/kg compared with that of 2010, down by 16% and the level of active reduction materials went down by 0.51 cmol/kg, a decrease of 28%. Compared with seasonal averages in 2010, total amount of reduction material in summer and winter fell by 15% and 11% respectively and the level of active reduction material shrank by 29% and 18% respectively. Other capacity indicators like the level of ferrous iron also had similar characteristics. Compared with 2010, soil sections were found to go through degleyfication, which was linked to the sinking of water table.

8.5 Characteristics of Water-salt and Salinization of the Estuary of the Yangtze River

8.5.1 Water-salt Movement

In 2011, monitoring work at the estuary (land-sea interface) continued to focus on the monitoring on dynamic change of salt concentration of the water and soil salinization. Three monitoring sections were established at Yinyang, Daxing and Xinglongsha, the north tributary of the Yangtze River, about 4 km, 22 km and 35 km from the land-sea interface respectively, all perpendicular to the river bank. At each section, 3 south-north monitoring points were arranged. Major monitoring items included the water conductivity of the Yangtze River, water conductivity of inland river section, soil conductivity, and groundwater conductivity groundwater table.

● Water Conductivity of the Yangtze River

Water conductivity of the Yangtze River at all sections in the estuary was high in spring, autumn and winter and the conductivity was low in summer. In summer, water conductivity of the three monitoring sections gradually increased as they got nearer to the estuary. The yearly average conductivity of all sections has risen compared with that of 2010. The growth was particularly evident in spring, autumn and winter and Daxing and Xinglongsha section were the most representative. Water conductivity of Yinyang section was higher than that of the previous year as a whole and the monthly averages from September to December climbed by 72.5%. The yearly average of conductivity at Daxing section grew by 46.9% and the monitoring value in September increased threefold compared with the same period of 2010. At Xinglongsha section, water conductivity rose sharply in autumn and winter and the monthly averages from September to December were twice as high as that of the same period of 2010.

● Conductivity of Inland River

Conductivity of inland river at Xinglongsha section rose dramatically, exceeding the fluctuations of Yinyang section and Daxing section which were nearer to the estuary. The average conductivity at Yinyang section gained by 9.4% in spring compared with that of the same period of 2010 and the growth in autumn and winter was remarkable with monthly average from September to November jumping by 50.2%. The yearly average conductivity of Daxing section was close to that of 2006, a dry year in history and it went up by 47.9% compared with that of the same period of 2010. The monthly average between September and December went up by 61.3% compared with the same period of 2010. Annual average water conductivity of the inland river at Xinglongsha section was 2.6 times as high as that of 2010. The monitoring value of the first half year reached historical high and the records of the second half year were also far higher than that of the same period of 2010. Particularly, the monthly average from October to December soared by 227.9% and 89.0% respectively compared with the same period of 2010 and 2006. There existed high positive correlation between conductivity of inland river at all the three estuary monitoring sections and that of the Yangtze River and there was a strong link between the conductivity of the Yangtze River and inland river.

● **Groundwater Table**

The water table tended to decrease as the monitoring sections got near to the estuary. Over the past two years, water table at Yinyang section and Daxing section has gradually reduced whereas the water level at Xinglongsha section tended to increase. Groundwater at Yinyang section was shallow, especially between September and December. This area saw less rainfall and more evaporation compared with that of 2010 and salt in the soil was prone to accumulation. Water level at Daxing section was higher than historical annual averages and it reached minimum from June to December. Affected by reduced water from upstream and the relatively big distance to the estuary, Xinglongsha section had less groundwater recharge from the Yangtze River, so that the annual average water table at this section increased by 15.6% and 13.5% respectively compared with the same period of 2010 and 2006 and the average water table between October and December rose by 38.8% compared with the same period of 2010.

Monitoring sites on dynamic changes of soil and groundwater salt concentration

● **Groundwater Conductivity**

Groundwater conductivity at all the three monitoring sections has increased a bit and the growing trend was most obvious in autumn and winter. Groundwater conductivity at Yinyang section was higher than that of Daxing section, which was the middle one among the three. Due to the influence of intruding water from the Yangtze River, groundwater conductivity at Xinglongsha section had a marked increase. Annual average groundwater conductivity at Yinyang section increased by 2.8% compared with that of 2010 and the monthly average from September to December rose by a large margin compared with the same period of the dry year 2006. Groundwater conductivity at Daxing section was higher than ever and the monthly average between September and December was 2.82 times as high as the same period of 2010. Groundwater conductivity at Xinglongsha section also posted historical high. There was a strong correlation between the groundwater conductivity at Yinyang section and that of the Yangtze River. Groundwater conductivity at Daxing section and Xinglongsha section was closely related to water conductivity of both the Yangtze River and inland river.

8.5.2 Monitoring on Soil Salinization

Soil conductivity of the three monitoring sections at the estuary was connected with the distance between the section and the estuary. Soil conductivity at Yinyang section, which was the most close to the estuary, showed higher conductivity than that of Daxing and Xinglongsha section. Soil conductivity at Yinyang section was higher than the same period of 2010 and its annual average has increased 1.8 fold. Soil conductivity at Daxing section also rose a little. The monitoring result of Xinglongsha section was close to that of the previous year and the values remained high. The middle and upper soil layer of Yinyang section grew salinized and the average soil conductivity from September to December was 1.1 fold and 2.4 fold higher than that of 2010 and 2006 and the accumulation of salt during this period was notable. The average soil conductivity of Daxing section of September and December increased by 15.4% compared with the same period of 2010. Soil conductivity of the upper and middle layer of Yinyang section and Daxing section was closely connected with groundwater depth and the soil conductivity of topsoil of Xinglongsha section was extremely connected with groundwater depth.

Analysis of soil sample from fixed monitoring plots indicated that soil salt concentration of Yinyang Town grew strongly in autumn and reached slight to middle level of salinization. Soil salt concentration on spatial dimension showed that North Branch of the estuary saw pretty obvious trend of salinization and the salt concentration in recent years continued to rise. Soil salt level at the intersection of rivers grew considerably, suggesting that areas with much increase of salt concentration were largely places where rivers meet.

8.6 Ecological Environment of the Estuary of the Yangtze River

8.6.1 Environmental Elements of Waters

● **Hydrological Characteristics**

In the spring of 2011, water temperature of the Yangtze River estuary was high in surface layer and low in bottom layer, high off the coast and in the estuary and low near the coast, high in the south and low in the north. The maximum temperature was 18.76℃ and the minimum was 14.28℃. In autumn water temperature was low near the coast and high off the coast with maximum and minimum being 21.02℃ and 17.84℃ respectively. Temperature in surface layer was slightly lower than that of the bottom layer. Water temperature in spring was lower than that of the same period of 2011 with maximum and minimum temperature down by 3.7℃ and 0.1℃ respectively. Water temperature in autumn was higher than that of 2011 and the maximum and minimum temperature were 1.25℃ and 2.47℃ higher than that of the previous year.

In spring the salinity of near coast waters at the Yangtze River estuary was lower than 28.00. The salinity in the east was a little higher with the maximum being 31.64. It exhibited a pattern of low salinity in near coast waters and high in off coast waters. The expansion of diluted water to the east was not as strong as that of 2010 in the spring so that the maximum salinity was higher than that of 2010 by 0.60. In autumn, salinity was low at the South Branch and high in other waters and maximum salinity was lower than that of 2011 by 0.27.

Affected by the water of the Yangtze River, transparency of the waters was low at estuary and near coast waters and high in off coast waters. Transparency was below 1 meter west of 122° 30′ E and between 1-2 meters in waters at 122° 30′ -123° 00′ E. It was above 2 meters in waters east of 123° 00′ E. The maximum was 3 meters, similar to that of the previous year.

● **Water Chemistry**

In 2011, the average level of dissolved oxygen in the surface layer of Yangtze River estuary was 8.34 mg/L and 8.48 mg/L respectively in spring and autumn. In the sea area, the average level was 8.29 mg/L and 7.48 mg/L respectively. The level of dissolved oxygen outside the estuary was high in surface layer and the level dropped as it went deep. The concentration of dissolved oxygen in the river section was much lower than that of 2010 either for surface layer or bottom layer. In seawaters, the level of dissolved oxygen in spring was lower than that of the same period of 2010. In autumn, the level of surface layer was lower than that of corresponding period of 2010 and in bottom layer, it was higher than that of 2010.

The average pH value of the river section in the Yangtze River estuary in the surface layer was 7.82 and 7.97 in spring and autumn respectively and that of the bottom layer was 7.73 and 7.98 respectively. In seawaters, the average pH value in the surface layer in spring and autumn was 7.87 and 8.03 respectively and that of the bottom layer was respectively 7.90 and 8.04. The change pattern of the pH value was that it was low in the river waters and high in seawaters. Compared with that of the previous year, pH value in river waters was higher in spring except that of the bottom layer.

In the Yangtze River estuary, the average level of permanganate in the surface layer in spring and autumn was respectively 2.820 mg/L and 3.022 mg/L and that of the bottom layer was respectively 2.762 mg/L and 3.732 mg/L. The level of permanganate in the surface layer of seawaters in spring and autumn was 1.192 mg/L and 1.692 mg/L respectively and that of the bottom layer was respectively 0.842 mg/L and 1.612 mg/L. Affected by inflowing water, the level of COD demonstrated a change pattern of high concentration in the estuary and near coast waters and low concentration in off coast waters. COD level of inland river was basically higher than that of previous year and that of seawaters was mostly lower than the same period of 2010.

The level of phosphate, silicate, nitrate, TN and TP reduced dramatically from the Yangtze River estuary to off coast waters. The distribution of NH_3-N and nitrite was rather complicated. The change pattern of nutrients was different from that of 2010. The level of phosphate was higher and that of silicate in inland rivers was lower in spring and much higher in autumn. The silicate level in the bottom layer of seawaters was higher than the same period of 2010. The level of nitrate in spring was close to that of 2010 and in autumn it was much higher. The level of nitrite in inland rivers was higher than that of 2010 and the level in seawaters was higher than that of 2010 in spring and a little lower in autumn. NH_3-N concentration in inland rivers was higher in spring and lower in autumn whereas that of seawaters was remarkably higher than the same period of 2010. The level of TN in spring was lower than the spring of 2010 and in autumn the level was a bit lower in the surface layer and higher in the bottom layer. The TP concentration in inland rivers was close to that of 2010. The level in seawaters was lower in spring and in autumn the level of TP in surface water was close to that of 2010 and higher in the bottom layer.

Table 8–1 Concentration of nutrients of Yangtze River estuary in spring and autumn of 2011

Unit: μmol/L

Time	Nutrient	River section		Sea area	
		Surface layer	Bottom layer	Surface layer	Bottom layer
Spring	phosphate	1.4	1.4	0.6	0.6
	silicate	41.7	34.9	17.9	15.2
	nitrate	72.0	75.4	26.0	17.9
	nitrite	0.8	1.0	0.9	0.9
	NH_3-N	8.9	9.8	7.3	8.7
	TN	135.8	136.8	57.4	46.6
	TP	3.6	4.2	1.7	2.0
Autumn	phosphate	1.8	1.4	1.0	1.0
	silicate	107.5	100.0	27.5	25.9
	nitrate	145.1	143.8	30.8	28.4
	nitrite	0.9	0.8	0.5	0.4
	NH_3-N	3.3	3.2	13.4	13.8
	TN	149.1	149.6	48.5	48.6
	TP	3.4	3.9	2.5	3.8

● **Sediment**

In 2011, the level of suspended matters in estuary waters was higher in the spring than that in the autumn of 2010. The average concentration registered 108.22 mg/L in the spring and 67.64 mg/L in the autumn. The level of suspended matters in the surface waters varied largely from season to season. In spring the maximum level reached 955.06 mg/L and the average level was 138.29 mg/L whereas in autumn the maximum and average level dropped to 382.22mg/L and 46.39 mg/L respectively. Concentration of suspended matters in bottom layer had small seasonal difference. The maximum and average level in spring was 1167.17 mg/L and 183.95 mg/L respectively and that in autumn stood at 1507.89 mg/L and 164.51 mg/L respectively. Compared with the same period last year, concentration of suspended matters in spring declined a little and the level was higher in autumn. In terms of horizontal distribution, the level of suspended matters at Yangtze River estuary gradually fell from near coast waters to off coast waters. Specifically, suspended matters abounded at Hangzhou Bay estuary which is close to the south of

Nanhuizui. The level of suspended matters in bottom layer was all higher than that of surface layer.

8.6.2 Biological Factors in Waters

● **Chlorophyll-a**

In 2011, the level of chlorophyll-a in estuary waters in spring was much higher than that in autumn. Chlorophyll-a level in surface layer in spring ranged between 0.15-8.04 μg/L with average level at 1.22 μg/L. The area with high chlorophyll-a level was mainly distributed in the east part of seawaters under investigation, near the open sea. Chlorophyll-a level in surface layer in autumn fell between 0.02 μg/L and 3.78 μg/L with an average level of 0.413 μg/L. The area with high chlorophyll-a level was found in the central part of seawaters under investigation, close to the belt with maximum turbidity.

In bottom layer, the chlorophyll-a level in spring was from 0.05 μg/L to 1.47 μg/L, averaged at 0.515 μg/L. The areas with high chlorophyll-a level was mostly around diluted water of the Yangtze River. The chlorophyll-a level in autumn was between 0.02 μg/L and 0.37 μg/L, averaging at 0.20 μg/L. The northern part of the monitoring area, near the interface between the Yellow Sea and the East Sea had a high level of chlorophyll-a.

● **Fish Zooplankton**

A total of 17,872 fish zooplankton was caught in the spring of 2010 that fell into nine families in six orders including 16,719 spawns and 1,153 fries. Identified fish and zooplankton numbered 12 species. The dominant species of fish zooplankton in the estuary waters was anchovy. The abundance of fish zooplankton was much higher than that of last year. Compared with the same period last year, anchovy maintained dominance whereas small yellow croaker lost their dominance.

A total of 220 fish zooplankton was caught in the autumn that fell into 12 species, eight families in seven orders, including 63 spawns and 157 fries. The dominant fish zooplankton in the estuary area was stolephorus commersonii and hairtail spawns. Compared with the same period last year, the abundance and amount of species did not vary much and hairtail kept its absolute dominance. Thryssa kammalensis lost its dominance, and stolephorus commersonii became the most dominant species.

● **Fishery resources**

In 2011, 36 fish species of 25 families in eight orders were caught in the spring with dominant species being tapertail anchovy and small yellow croaker. Resource abundance and resource biomass were respectively 37,450 fries/km^2 and 334.78kg/ km^2. In autumn the caught fish included 39 species of 27 families in eight orders, dominated by hairtail, Bombay duck, small yellow croaker, Setipinna taty and silvery pomfret. Resource abundance and resource biomass were respectively 68,510 fries/ km^2 and 920.13kg/ km^2.

Compared with the same period last year, the species and amount of fishery resources did not change much. In the spring, dominant species changed in which the Bombay duck, Setipinna taty and silvery pomfret lost their dominance and tapertail anchovy enjoyed higher degree of dominance. In autumn, hairtail and the Bombay duck maintained their dominance and small yellow croaker and silvery pomfret entered into the ranks of dominant species. The diversity of fishery life-forms increased significantly.

8.7 Monitoring and Studies on the Wetlands in the Middle Reaches of Yangtze River

8.7.1 Dongting Lake

● **Hydrological Characteristics**

Dongting Lake has four inflow rivers (Xiangjiang River, Zishui River, Yuanjiang River, and Lishui River) in the south and empties unto Yangtze River in the north. The contributing influx of the lake includes the aforementioned four rivers, three bleeders of Yangtze River (including the 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 storage lake of Yangtze River.

The influx to Dongting Lake in 2011 fell dramatically and the rainfall from January to May reached historical low since 1951 and was 41.6% short of the average of the same period of historical years. Major hydrological stations of the lake area experienced less annual runoff by 29%-98% and less sediment transport volume by 63%-99.9% compared with the average of historical years. In particular the annual runoff and sediment transport volume dropped by 33%-90% and 44%-96% respectively compared with that of 2010. The year-on-year influx at Chenglingji went down by 60%-70% between April and May, which caused conspicuous low water. The upstream of Xiangjiang River witnessed the lowest compared with the same period of historical years. In June Dongting Lake waters was hit by a biggest flood in the year, resulting in record water level and runoff in Xiangjiang River and Zishui River in 2011. In September, water level of Xiangjiang River reached historical low. During the flood period from April to October, the monthly influx to all tributaries was less than historical averages except Lishui River which had more influx in October. The aggregated flow of the four inflow rivers went down by 20% in June and October respectively and by 50% plus in other months. In 2011, the biggest sediment peak at Chenglingji station and Luoshan station appeared on June 12, the main flood season, with the momentary maximum index sediment concentration at 0.326kg/m^3 and 0.225kg/m^3 respectively. The second biggest sediment peak arrived on Mar. 24 of the spring flood period and the second biggest momentary index sediment concentration at the above two stations was respectively 0.225kg/m^3 and 0.152kg/m^3.

The 60-day (from June to August) monitoring of flood volume in 2011 showed that the inflowing volume to Dongting Lake and its outflowing volume totaled 51.19 billion m^3 and 48.86 billion m^3 respectively, leading to a total water storage of 2.33 billion m^3. The four inflow rivers contributed above 57.1% of the source waters into the lake, and the three bleeders of the Yangtze River contributed between 10.6% and 33.5%. Inflow to the lake area was the least, accounting for 9.4%-18.0%. The Yangtze River fed water to the lake through its three bleeders mainly between January and May. Between June and October, 75% of the inflow at the Chenglingji Station, the lake outlet, derived from the four inflow rivers, and during the other period of the year 49.3% was from these rivers. 68.6% of the annual average inflow of Luoshan Station came from the Yangtze River.

● **Water Quality of Dongting Lake**

The sections where the four rivers (Xiangjiang River, Zishui River, Yuanjiang River, and Lishui River) flowed into the lake recorded Grade II to Grade III standard water quality. Water from the three bleeders was of poor quality, mostly between Grade III and Grade IV standard. Water from the inflowing sections of Songzi Bleeder and Taiping Bleeder even recorded Grade V standard in some months. The eight monitoring sections distributed in the lake body and outlet recorded mainly Grade IV standard water quality, falling short of the water quality objectives of water function zones. Pollution from total phosphorus and total nitrogen was serious with total phosphorous at Grade III to Grade V level and total nitrogen at Grade V to worse than Grade V level.

Monthly monitoring results indicated water quality of east Dongting Lake fluctuated largely whereas the south and west Dongting Lake had fairly stable water quality. The outlet of the lake recorded poor water quality in January, February and March. In 2011, among the 16 monitoring lake sections, 52.9% posted Grade I to Grade III standard. The water was slightly polluted from total phosphorous, total nitrogen and dissolved oxygen.

In 2011, Dongting Lake was measured at mesotrophic level with comprehensive trophic state index between 45.9 and 50.0. Yugongmiao Section had the highest index, falling into the category of eutrophication. The level of trophic state in the west Dongting Lake was lower than that of the south and east Dongting Lake. In March and May, the lake was of slight eutrophication and in other months it was in mesotrophic state. In 2011, phytoplankton belonging to 74 genera of 8 phylums were found in the lake including 31 genera of Chlorophyta (the largest in number), followed by 21 genera of Bacillariophyta, 10 genera of Cyanophyta, 4 genera of Euglenophyta, 3 genera of Pyrrophyta, 2 genera of Chrysophyta and Cryptophyta respectively and a genus of Xanthophyta. Except Chrysophyta and Xanthophyta, the other 6 kinds could all be found in the entire lake throughout the year. There was no clear rule by which phytoplankton succeeded seasonally. The common species of Bacillariophyta, Euglenophyta and Cryptophyta have kept dominance in phytoplankton. There was distinct seasonal change in the amount and biomass of phytoplankton in Dongting Lake, both taking place in the end of spring and beginning of summer (in May).

● **Characteristics of the Vegetation at the Dongting Lake Wetlands**

Fixed-site observation was carried out in 6 typical shoals including Liumenzha, Beizhouzi, Tuanzhou, Junshan, Chunfeng and Jianxing farm in 2011. The results suggested the representative communities of the lake such as Triarrherca Sacchariflora, Carex and Polygonum hydropiper had strong characteristics in different seasons. The number of species, coverage, abundance and biodiversity index of florales all changed like single peak curve where the maximum appeared in March and the value dropped to a low level in January and November. Compared with Triarrherca Sacchariflora, Carex had fewer species and the number of species reached maximum in March and minimum in May. With a relatively low level of abundance, the number of coexistent species was small. The coverage of the Carex community was high and it dwindled as time went by in the year. Higher level of coverage was found in January and March and the level got lower in November. Biodiversity index was the highest in March and it went lower in January and November. The number of species of Polygonum hydropiper was the biggest in March and smallest in January, but the abundance did not change much in different months. Community coverage reached its high in May and dropped the lowest level in November. Its biodiversity index was higher in January and March and fell to the lowest level in November.

● **Biodiversity Characteristics of Dongting Lake Wetlands**

The east Dongting Lake embraced quite rich biodiversity in 2011, about 50-60 species of water birds, a significant increase compared with the number of last year. The number of anser fabalis discovered in the survey rose by 16,000, the biggest increase in number. Among Level I national protected birds, there were 75 ciconia nigra, representing the biggest increase in number. However, the number of ordinary cormorant diminished sharply by nearly 70%. Wild geese, inhabiting on the lake beach and feeding on grass and other vegetation, took up nearly 67% of total birds. Plovers and sandpipers that live in mud flat or shallow waters and feed on benthos and small fish were of different varieties but the number was small. Birds that live on fish have shrunk quickly. Anser erythropus, the representative species of east Dongting Lake, accounting for 60% of global wintering population, maintained a fairly stable number. The distribution area of birds at the east Dongting Lake was quite stable. They were densely distributed in Zhuzi estuary of Baihu Lake and in waters east of Heizui, the enclosed zone of the big and small west lake and the bund of Chunfeng Lake.

In 2011, the population of the naturally wild elaphurus davidianus in east Dongting Lake gradually increased compared with that of the previous years and the number has risen to 50. They were steadily distributed in the downstream of Zhuzi River and the Hongqi Lake area. There were two individual species in the East Dongting Lake national nature reserve, that is black-mouth elaphurus davidianus (about 34-36) and Piaowei elaphurus davidianus (about 16-18).

8.7.2 Poyang Lake

● **Hydrological Characteristics**

As the biggest freshwater lake in China, Poyang Lake sits on the southern bank of the Yangtze River and in the north of Jiangxi Province. Converging five big rivers (Ganjiang River, Fuhe River, Xinjiang River, Raohe River and Xiuhe River) and inflowing water from Boyang River, Zhangtian River, Qingfengshan Brook and Tongjin River, Poyang Lake feeds the Yangtze River at its estuary. This ephemeral freshwater lake both takes in water and sends out water. When the water level is high, it is as plentiful as a lake; when the water level is low, it runs as a river. This gives the lake the unique form of vast expanse of waters in flood season and a thread of water in low water period. The lake area and capacity differed enormously. When the water level of Xingzi Station of Poyang Lake reached 22.52 meters (Wusong base level), the lake surface area was 4905 km^2. (including the area of four sub-zones for flood storage such as Kangshan, Zhuhu Lake, Huanghu Lake and Fangzhou Tilted Pond) with a capacity of 38.7 billion m^3. When the water level dropped to 7.11 meters, the corresponding lake surface area was 244 km^2. with a capacity of 760 million m^3. Historical data suggested that among the five big inflowing rivers, Ganjiang contributed the most water to Poyang Lake, accounting for 46.7% while the contribution of Fuhe River, Xinjiang River, Raohe River and Xiuhe River was 11.3%, 14.2%, 11.3% and 9.2% respectively.

From April 2011 to March 2012, the average precipitation at Poyang Lake on a cumulative basis was 1,398mm, 3.8% less than historical years. The spatiotemporal distribution of rainfall was uneven. Precipitation in the flood season from April to September took up 79% of the total. Inflowing water from the five rivers to Poyang Lake totaled 93.4 billion m^3, 22.6% less than the average of previous years and the volume between April and September accounted for 68.8% of the total. The outflow at the lake outlet stood at 117.9 billion m^3, 21.9% less than the average of the same period of historical years and the outflow from April to September made up 65.3% of the total.

Rainfall at Poyang Lake basin from April to May 2011 was exceptionally little, a record low of the same period in previous years. This caused extremely low water level of the lake. On May 4, water level of Xingzi Station fell to 8.65 m, the lowest in the flood season, which was 5.41 m lower than the average of the same period of historical years. The total inflowing water amounted to 12.16 billion m^3, a decrease of 67.5% compared with the average level the same period of previous years. The lake area suffered from large scale drought from the spring to the summer. During June and July, some tributaries of Poyang Lake experienced flood beyond the alarm line and super flood. Xingzi, Duchang, Tangyin and Kangshan Station saw highest water level of the year and the maximum level at Xingzi Station hit 17.42 m (alarm line at 19 m) on June 22. The lake surface area expanded to 3,526 km^2. with a capacity of 13.17 billion m^3. Affected by the floods of the Yangtze River from August to September, Poyang Lake was impounded twice by the Yangtze River. The first impoundment took place at 8.5 am on Aug. 13 till 8 am on Aug. 15 with a maximum flow of 176m^3/s. The impounded water totaled 30 million m^3. The second impoundment happened at 8.4am on Sep. 24 till 8am on Sep. 27 with a maximum flow of 419m^3/s and water volume of 95 million m^3. The water level became steady from October to December as water retreated. Lowest water level began to appear among all stations successively. The minimum level of Xingzi Station at 8.05 m happened on Dec. 31, accompanied by 207.5 km^2 of lake surface area and 415 million m^3 of capacity. Water flow of Poyang Lake kept stable from January to February 2012 and there was a little change in water level with rainfall. Early flood arrived South Jiangxi and North Jiangxi in March which caused flood beyond alarm line in some tributaries of the lake basin. The total inflowing water to the lake reached 22.7 billion m^3, 12.0 billion m^3 more than that of historical years. The outflow totaled 25.7 billion m^3, 13.7 billion m^3 more than that of historical years.

● **Water Quality of Poyang Lake**

Water quality of Ganjiang River, Fuhe River, Xinjiang River, Raohe River and Xiuhe River remained good from April 2011 to March 2012 with average up-to-standard rate being 90.7%. Monthly monitoring of water quality and water volume was conducted in six hydrological control stations, namely Waizhou, Lijiadu, Meigang, Dufengkeng, Shizhenjie and Yongxiu. Best water quality occurred in April 2011 where 98.5% of water met related water quality standard. Major substandard pollutants flowing into the water body included NH_3-N and total phosphor. About 43.8% water of the lake area met water quality standard on average and the main pollutant that failed to meet standard was total phosphor. The water body of Poyang Lake was in the state of slight eutrophication. Water quality of the lake area changed dramatically from season to season. In flood season it had plenty of water and the water body had strong dilution and self-purification capability. Water quality was quite good and the best quality was seen in June 2011 with up-to-standard rate of 94.4%. In low water period, there was small amount of water and the carrying capacity of water environment was small. The lake was of poor water quality during this period of time and the worst quality happened in October 2011 with up-to-standard rate of only 11.1%. The water of the Poyang Lake flew to the Yangtze River at its outlet and the up-to-standard rate of outflowing water was 50.0% with main pollutant being total phosphor.

● **Vegetation Characteristics**

In 2011, fixed-point observation of the Poyang Lake wetland and shoal indicated strong seasonal characteristics of vegetation biomass and community forms in four representative zones, namely Lei Artemisia zone, Carex cinerascens Kukenth zone, Phalaris arundinacea zone and mud flat zone. Lei Artemisia, Carex cinerascens Kukenth and Phalaris arundinacea had all bourgeoned at the end of February. The biomass and dominance of Phalaris arundinacea reached its high in late April. After that the height of dominant species started to wither away and biomass gradually declined. The biomass of Lei Artemisia and Carex cinerascens Kukenth continued to grow till June when the first flood took place. The dominant plants reached their maximum height in the beginning of May. Then they gradually blossomed and fruited and the height and single plant weight did not change much. Vegetation of the mud flat zone dominated by *Lobelia chinensis Lour, Rumex japonicus* and *Alopecurus aequalis* began to shoot up in early March. The community biomass did not grow much in March but it started to proliferate from April till late May. After flood, *Carex cinerascens Kukenth* recovered rapidly. Its community biomass and the height of dominant species reached its peak in the middle of December and then leveled off. Some plants in the Lei Artemisia zone came back and the community biomass gradually grew between September and November but the growth was not remarkable. A handful of leaves at the top of the dominant plants in the Phalaris arundinacea zone turned green but its biomass did not increase much. Vegetation of the mud flat zone dominated by *Rumex japonicus, Carex cinerascens Kukenth, Polygonim plebeium* and *Gnaphalium affine* recovered fast in late October. The growth of community biomass continued till it reached the peak in late December. Before flood, the biodiversity index and abundance of species of communities in the Lei Artemisia zone and *Phalaris arundinacea* zone climaxed in the middle of April while after flood the peak arrived in late November. The abundance of species in the *Carex cinerascens Kukenth* zone was the riches in late March whereas biodiversity index of the community did not vary much in different time period. The biodiversity index and abundance of species of communities in the mud flat zone came to its height in mid May before flood while after flood they peaked in mid December.

● **Biodiversity Characteristics**

The 2011 survey on wintering water birds at the Poyang Lake found over 590,000 birds of 51 species. Among them the population of 14 species reached 1% of the world's total. For instance, there were 108,771 *Anser cygnoides*, nearly twice as many as the estimated global number, 4577 *Grus leucogeranus* and 4,052 Ciconia boyciana, both of which have exceeded the estimated global number. There were also 85,909 cygnets, more than 28% of world's total, 885 white-naped cranes and 49,491 *Recurvirostra avosett*a, accounting for over 13% and 10% of the world's total respectively. *Platalea leucorodia* and *Anser fabalis* numbered 11,838 and 68,237, over 8% of the total of the world respectively. There were 302 *Grus monacha*, taking up 3% of the world's total and 58,208 *Anser albifrons*, 657 *Anser erythropus*, 8,408 common cranes and 8,371 T*ringa erythropus*, exceeding 2% of the total number of the world. The 581 *Anas falcata* also accounted for more than 1% of the world's total.

8.8 Monitoring and Studies on the Small Watersheds in the Upstream of Yangtze River

8.8.1 Yangjichong Watershed in Longli County, Guizhou Province

Yangjichong Watershed in Longli County, Guizhou Province in Southwest China belongs to the Wujiang Waters in the Yangtze River Basins. The watershed covers 11.89 km^2, and the soil erosion area reached 7.41 km^2. The lands are mainly used as woodlands and farmlands.

In 2011, Longli Monitoring Station recorded 49 rainfalls, with total precipitation at 535.1 mm, a reduction of 94.4 mm, or 15% compared with last year. This was a typically dry year. The precipitation between May and September accounted for 70% of the total, with maximum daily precipitation at 49.8mm. The second biggest rainfall measured 72.7 mm, the maximum monthly precipitation and half-hour maximum precipitation was respectively 194.73 mm and 6.75 mm.

The monitoring data of the slope runoff plots showed that runoffs produced by runoff plots under different land use models were of different volume. The volume in descending order was as follows: cash tress runoff plot > bare land runoff plot > cropland runoff plot > grassland runoff plot > woodland runoff plot. The runoff yield was respectively 44.85 m^3, 39.64 m^3, 29.75 m^3, 24.00 m^3 and 11.74 m^3. The sediment yield of these plots in a descending order was as follows: control plot >cash tree runoff plot > bare land runoff plot > grassland runoff plot > woodland runoff plot. The sediment yield was respectively 56.16 kg, 39.01 kg, 16.89 kg, 16.37kg and 2.74 kg.

The monitoring station at the outlet of the watershed observed 7 obvious floods throughout the year, mainly between May and November. The flood peak was observed on May 22, with flow rate at 4.6 m^3/s. The runoff yield throughout the year totaled at 413,400 m^3, the annual runoff depth was 145.56mm, and the annual runoff coefficient was 0.35. The bed load at the outlet totaled 4.31 t, the suspended load totaled 46.7 t, accordingly the annual soil erosion totaled 51.01 t, and the erosion modulus was 17.96 t/(km^2•year).

Monitoring of soil physical and chemical properties included organic matter, total nitrogen, total phosphor, total potassium, nitrate nitrogen, ammonium nitrogen, effective phosphor, quick-acting potassium, soil porosity and mechanical composition. According to monitoring results, the concentration of organic matter, total nitrogen and total phosphor in various plots are sequenced as follows: cash tree runoff plot > woodland runoff plot > cropland runoff plot > grassland runoff plot > control plot. The content of total potassium and ammonium nitrogen followed the sequence of control plot > cash tree runoff plot > woodland runoff plot > grassland runoff plot > cropland runoff plot. The concentration of nitrate nitrogen was high in cropland runoff plot, followed by cash tree runoff plot, woodland runoff plot, control plot and grassland runoff plot. Effective phosphor was rich in cash tree runoff plot, followed by cropland runoff plot, woodland runoff plot, control plot and grassland runoff plot. There was no obvious difference among all plots in the level of porosity.

The loss of TN, ammonium nitrogen, nitrate nitrogen, TP and phosphate was most heavy in cropland runoff plot (planted with Abelmoschus esculentus), followed by cash tree and fruit tree plot (planted with waxberries, peaches and pears) and woodland plot. Grassland plot and the control runoff plot lost least of these nutrients. The level of ammonium nitrogen and nitrate nitrogen in the runoff was closely connected with precipitation. The level of TN, however, had little to do with precipitation, but its overall level was quite high. The level of phosphate in the runoff was a function of rainfall, but the level of TP did not have obvious relationship with rainfall. Preliminary estimate suggested TN and TP lost in the runoff of Yangjichong watershed throughout the year totaled 508 kg and 79 kg respectively.

8.8.2 Maojiawan Watershed in Bijie Prefecture, Guizhou Province

Maojiawan Watershed in Bijie Prefecture, Guizhou Province in Southwest China belongs to the Chishui River Basins in the upstream of the Yangtze Rivers. Covering an area of 3.98 km^2, the watershed is located at an altitude between 620 m and 1340 m with an average of 992.51 m. The gradient was from 0 to 72.5, averaged at 21.9. The area with a gradient from 15 to 25 accounted for the biggest par of the watershed, reaching 1.34 km^2.

In 2011, Bijie monitoring station observed 56 rainfalls with a total precipitation of 499.9 mm, 490.3 mm less, or nearly 50% reduction compared with that of historical years. In terms of runoff yield of runoff plots with different gradient, 5°plot did not produce runoff, 15° plot yielded 14.83 m^3 and 25° plot yielded 23.13 m^3. The runoff yield of 25°plot was much more than that of 15° plot. In terms of sediment yield, 5°plot did not produce sediment, 15°plot produced an average of 4.19 kg sediment with erosion modulus of 41.88 t/(km^2• a) and 25°plot yielded 12.75 kg with erosion modulus of 127.45 t/(km^2•a). The sediment yield and erosion modulus of 25° plot was considerably bigger than that of 15°plot.

Water samples from the outlet of small watershed

Monitoring result at the outlet of Maojiawan watershed indicated 2 runoffs in the year, respectively on Oct. 2-3 and Oct. 13-16. The maximum runoff was 1.53 m^3/s with annual average runoff at 0.002 m^3/s. The runoff totaled 48300 m^3 and annual runoff modulus was 3.85×10^{-4}m^3/(km^2•s) with runoff depth and coefficient being 12.15 mm and 0.024 respectively. The maximum sediment transport rate within the year was 0.026 kg/s and the average level was 7.74×10^{-5} kg/s. The total sediment transport volume of the year stood at 2.44 t with sediment transport modulus of 0.61 t/(km^2• a).

Water quality monitoring of runoffs from runoff plots showed 5°plot did not produce runoff. The runoff yielded from 15°plot carried 1,703 mg TN, 359 mg NH_3-N and 86 mg TP while the amount carried by the runoff of 25° plot was 3,186 mg, 516 mg and 74 mg respectively. The amount of TN and NH_3-N taken away by runoff from 25°plot was much more than that from 15°plot, but the amount of TP carried by runoff from 25°plot was rather less than that from 15°plot.

8.8.3 Dawanxi Watershed in Yibin Prefecture, Sichuan Province

Dawanxi watershed belongs to Minjiang River basin in the upstream of the Yangtze River. Located among shallow cut hills, the watershed was at an altitude of 430 m on average with a high of 480 m and low of 390 m. The relative difference in elevation totaled 90 m. The representative tributaries of Dawanxi watershed in a control area of 0.33 km^2 was selected as the monitoring target.

In 2011, Yibin monitoring station observed 70 rainfalls with a total precipitation of 623 mm, 481 mm less or down 44% compared with that of historical years (1,104 mm). The monthly rainfall from May to September recorded 385 mm, or 61.8% of the total, which reduced by 444 mm, or 54% compared with that of previous years. There were 108 rainy days in the year.

6 runoffs were monitored in the slope runoff plots. The runoff yield of 5°plot and 15°plot was respectively 4.58 m^3 and 9.17 m^3. Sediment yield and erosion modulus of 5°plot averaged 0.174 kg and 1.74 t/(km^2•a) and that of the 15°plot was respectively 1.10 kg and 11.00 t/(km^2•a).

The monitoring station at the outlet of the watershed observed 6 obvious flood process, mainly from June to August, with a total runoff of 5,100 m^3 throughout

Rural household survey

the year. The bed load at the outlet was 1.37 t, the total suspended load was 31.53 t, and accordingly the annual soil erosion totaled 32.90 t.

The concentration of TN, NH_3-N, nitrate nitrogen and TP from the water samples of all the runoff plots averaged 0.395 mg/L, 0.421 mg/L, 0.206 mg/L and 0.014 mg/L respectively. The 5° plot produced 1,825.4 mg TN, 1,882.6 mg NH_3-N, 950.2 mg nitrite nitrogen and 27,807.1 mg TP. The amount produced by 15° plot was respectively 3672.0 mg, 3,909.8 mg, 1,950.3 mg and 53,281.4 mg. In general, TN, NH_3-N, nitrite nitrogen and TP lost from 15°plot was much more than that from 5° plot.

8.8.4 Xie-Jiawan Watershed in Suining Prefecture, Sichuan Province

Located in the Anju District of Suining Prefecture, Sichuan Province, Xie-Jiawan watershed was representative of hill landform. The exposed stratum belongs to the lower part of Suining section, Jurassic Mesozoic erathem. The rainwater catchment area was 68,900 m^2 and the average longitudinal river slope was 29.2‰. The watershed runs at a maximum altitude of 331.6 meters and a minimum altitude of 280.0 meters with relative difference in elevation of 51.6 meters. The hilly area of Fujiang River basin, the primary tributary of Jialing River, in central Sichuan, was the most densely populated area and the land was fully reclaimed. With temperature averaged at 18.2℃ year on year, the yearly precipitation and evaporation was 895.5 mm and 897.2 mm on average respectively. At the entrance where major tributaries flow into the Three Gorges Reservoir, the rainfall runoff directly goes into Fujiang River, the primary tributary of Jialing River.

In 2011, the highest temperature of area posted at 33.5℃ on Aug. 31 and the lowest was 0.3℃ on Jan. 21. The average temperature was 17.5℃. The precipitation throughout the year totaled 837.5 mm and rainy days numbered 112. The rainfall in the flood season reached 591.8 mm with 43 rainy days. The maximum daily precipitation measured at 62.1 mm on May 1 and the maximum monthly precipitation was 171.6 mm (in May).

Eight rainfalls were observed which took place respectively on May 1, May 2, June 21, June 22, July 5, Aug. 1, Aug. 3 and Aug. 4. The total runoff of the watershed reached 4,466 m^3, transporting 14,178 kg sediment. The maximum daily runoff and daily sediment transport volume was 1,124 m^3 and 3,665 kg respectively.

The soil bulk density of the typical farmland in the watershed was from 1.40 to 1.60 g/cm^3 with smaller bulk density in surface layer and bigger one in bottom layer. The difference was about 10%. The level of TN, TP and total potassium in the soil was respectively 2.90 g/kg, 0.83 g/kg and 22.24 g/kg. The concentration of organic matter, TN and TP in surface layer was all higher than that in the bottom layer while the level of total potassium in the surface layer was close to that in the bottom layer. Soil grain diameter was small, about 80% less than 0.02 mm and 90% less than 0.04 mm.

8.9 Monitoring and Studies on the Terrestrial Plants of the Reservoir Area

A comprehensive analysis and comparison of the 2005 and 2010 investigation results on terrestrial plants in the reservoir area was made in 2011, which suggested little change in biodiversity and a small increase in the average abundance of species of plant communities.

8.9.1 Characteristics of the Species Composition of Major Vegetation Types

Among the terrestrial plant communities in the Three Gorges Project, the average number of species of forest communities, shrub communities and hassocks was 29.9, 19.3 and 10.4 respectively and their ratio was about 3: 2: 1.

There were five major forest types including coniferous forest, evergreen broad-leaved forest, deciduous and evergreen broad-leaved forest, deciduous broad-leaved forest and bamboo forest. Among them, deciduous broad-leaved forest had the biggest number of species and the number of species at each sample plot averaged 31.8. There were 17.3 species of bamboo forest, the least of all and the number was far less than that of other forest communities and was even less than that of shrubs. Deciduous and evergreen broad-leaved forest had 16.3 species of arbor layer, the biggest number among forest types while the bamboo forest only had 1.5 species of arbor layer, the smallest number. The biggest number of species of bush layer was found in coniferous forest, totaled 13.2 species and the deciduous and evergreen broad-leaved forest only had 8.9 species, the smallest number of all. There were 9.1 species of coniferous forest belonging to the herbaceous layer, which was the most of all while there were only 4.7 species of the deciduous and evergreen broad-leaved forest fell in this category, which represented the smallest number.

The five types of forest communities had different number of species in arbor layer, bush layer and herbaceous layer. For coniferous forest and bamboo forest, the number of species was the biggest in bush layer, followed by herbaceous layer and arbor layer. Broad-leaved evergreen forest had the most varieties of species in the bush layer, followed by the arbor layer and the herbaceous layer. The deciduous and evergreen broad-leaved forest and the deciduous broad-leaved forest had the biggest number of species in the arbor layer, followed by the shrub layer and herbaceous layer.

8.9.2 Sequence of species number for major communities

● **Coniferous Forest**

There was a large number of species in Thuja

Table 8–2 Average species of major vegetation types in the Three Gorges Project area

Community types		Number of sample plot	Size of sample plot (meter)	Average number of species			
				Number of communities	Arbor layer	Shrub layer	Herbaceous layer
Forest	Coniferous forest	46	20×20	29.4	7.1	13.2	9.1
	Evergreen broad-leaved forest	50	20×20	30.2	10.9	12.0	7.3
	Deciduous and evergreen broad-leaved forest	29	20×20	29.9	16.3	8.9	4.7
	Deciduous broad-leaved forest	65	20×20	31.8	13.4	10.9	7.5
	Bamboo forest	10	20×20	17.3	1.5	9.6	6.2
	Average			29.9	11.2	11.3	7.4
Shrubs		64	5×5	19.3	0.0	10.0	9.3
Hassocks		76	2×2	10.4	0.0	1.2	9.2

Alsophila spinulosa

Cotinus coggygria shrub growing on limestone sutchuenensis community, Fir community and Cupressus community. The number of species in Pinus arrnandii community, Taxus mairei community and Pinus massoniana community was placed in the middle. Cryptomeria fortunei, Metasequoia glyptostroboides and Pinus Tabulaeformis communities had a small number of species.

● Evergreen Broad-leaved Forest

Communities having a large number of species include Macropodous Tigernanmu, Cyclobalanopsis oxyodon, nanmu, Castanopsis ceratacantha, Machilus ichangensis and Cyclobalanopsis myrsinaefolia. Castanopsis platyacantha, Cyclobalanopsis gracilis, Schima Superba, Root of Redfruit Actionodaphne-Litsea coreana, Quercus spinosa, Castanopsis, Lithocarpus hancei- Schima Superba-Sycopsis have smaller number of species. The number of species was the smallest in such communities as Cyclobalanopsis-Castanopsis platyacantha, Camphor, Cyathea spinulosa, Cyclobalanopsis, Gordoniaacuminata and Castanopsis carlesii.

● Deciduous and Evergreen Broad-leaved Forest

Lithocarpus hancei- Schima superba- Cyclobalanopsis multiervis W. C. Cheng et T. Hong-Carpinus fargesiana H. Winkl and Lithocarpus hancei-Acerdavidii Franch have a big number of species, followed by Euptelenpleiospermn- Firmiana simplex- enopterys henryi Oliv-Lithocarpus glaber, Davidia involucrate-Acer mono- Cyclobalanopsis oxyodon-Cinnamomum subavenium, Fagus lucida Rehd. & E. H. Wils.- Quercus engleriana Seem-Cyclobalanopsis multinervis Cheng et T. Hong, Betula insignis Franch- Sycopsis Oliv-Cyclobalanopsis multinervis Cheng et T. Hong and Padus wilsonii-Cyclobalanopsis oxyodon. There are some communities that only have a small number of species including Dipteronia sinensis Oliv- Tetracentron sinense-Cornus macrophylla Wall-Cyclobalanopsis oxyodon, Platycarya strobilacea Sieb. et Zucc.- Cyclobalanopsis glauca, Machilus microcarpa Hemsl- Lindera obtusiloba-Dipteronia sinensis Oliv, Tetracentron sinense-Cyclobalanopsis oxyodon-Quercus engleriana Seem, Sycopsis Oliv- Acer oliveranum Pax-Cyclobalanopsis multinervis Cheng et T. Hong, Fagus engleriana Seem-Cyclobalanopsis multinervis Cheng et T. Hong and Pterostyrax psilophyllus- Davidia involucrate-Quercus engleriana Seem.

● Deciduous Broad-leaved Forest

Carpinus fargesiana H. Winkl.- Castanea henryi, Castanea henryi,Betula luminifera H. Winkl., Quercus aliena-Quercus variabil and Castanea seguinii Dode have a big number of species, followed by Fagus lucida Rehd. & E. H. Wils., Quercus glandulifera var.brevipetiolata Nakai, Liquidambar formosana, Carpinus polyneura Franch., Quercus aliena var.acuteserrata, Choerospondias axillaris-Acer mono and Quercus variabil-Quercus acutissima Carr. Communities having a small number of species include Liriodendron, Fagus engleriana Seem., Anacardiaceae, Carpinus cordata and Robinia pseudoacacia L.

● Bamboo Forest

Phyllostachys nidularia has a much larger number of species than Phyllostachys edulis.

● Shrubs

The number of species is big in such communities as Lindera fragrans, Celtis biondii Pamp., Dyetree, Salix wilsonii Seem., Cotinus coggygria and Vitex negundo. Sageretia thea, Buxus sinica, China Wingnut, Viburnum chinshanense Graebn., Spiraea chinensis, Coriaria sinica, Ilex bioritsensis Hayata, Pyracantha and Abelia chinensis have a smaller number of species. There were only a few species in such communities as Myrsine africana Linn, Swida paucinervis (Hance) Sojak, Rubus and Lespedeza cuneata.

● Hassocks

Beckmannia syzigachne, Neyraudia reynaudiana (kunth.) Keng, Eichhornia crassipes, Cynodon dactylon(L.)Pers., Miscanthus and Paspalum distichum L.have a big number of species, followed by Acorus calamus, Phragmites australis, Setaira viridis (L.) Beauv, Miscanthus sacchariflorus, Pseudoraphis spinescens, Heteropogon contortus and Eulaliopsis. Communities having smaller communities of species include Carex tristachya, Imperata latifolia, Roegneria kamoji Ohwi, Arthraxon, Digitaria, Isachne globosa and Polygonum chinense Linn.

Organizer:
Department of Reservoir Management, Executive Office of the State Council Three Gorges Project Construction Committee

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

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