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

2010

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

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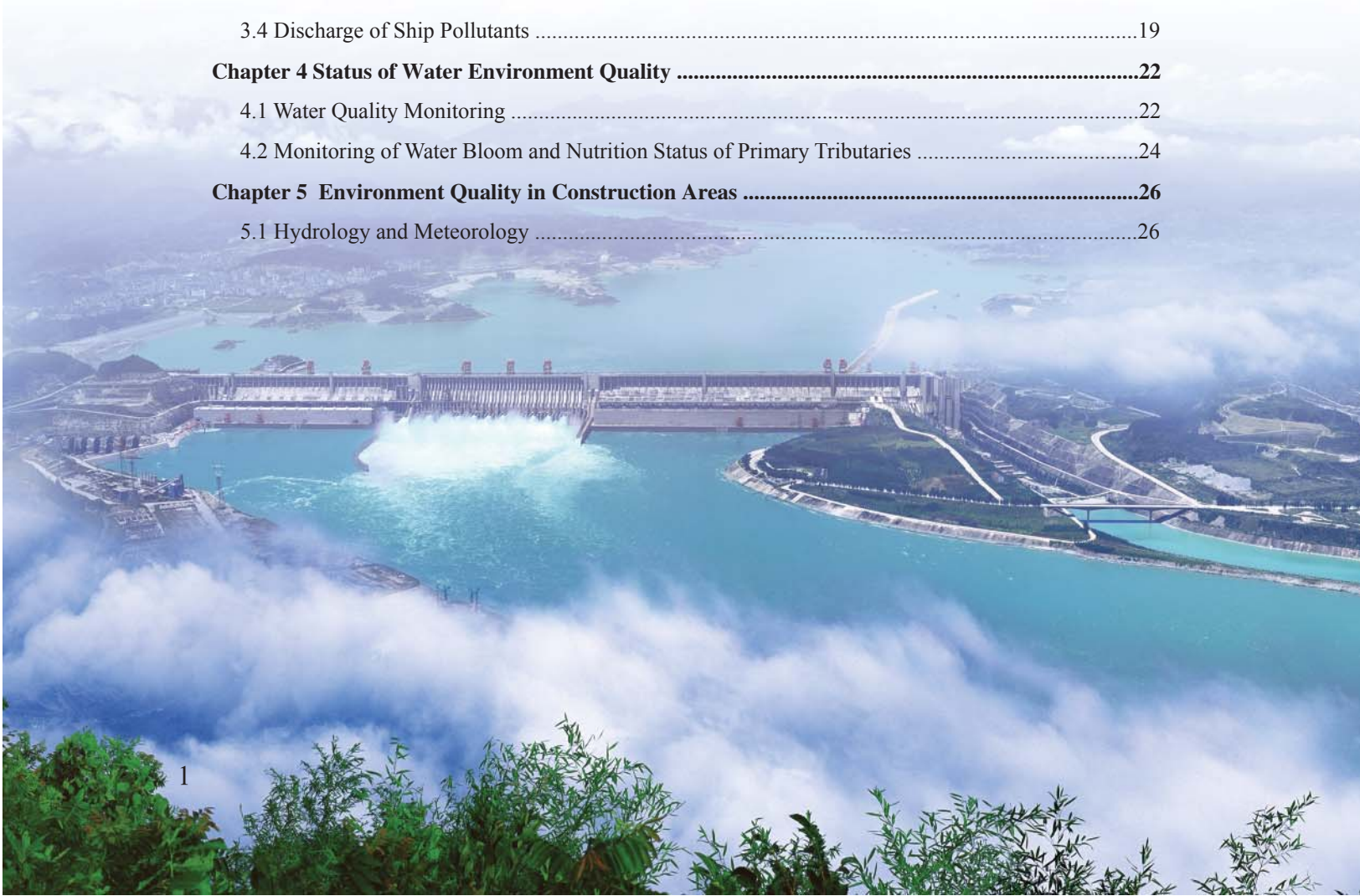
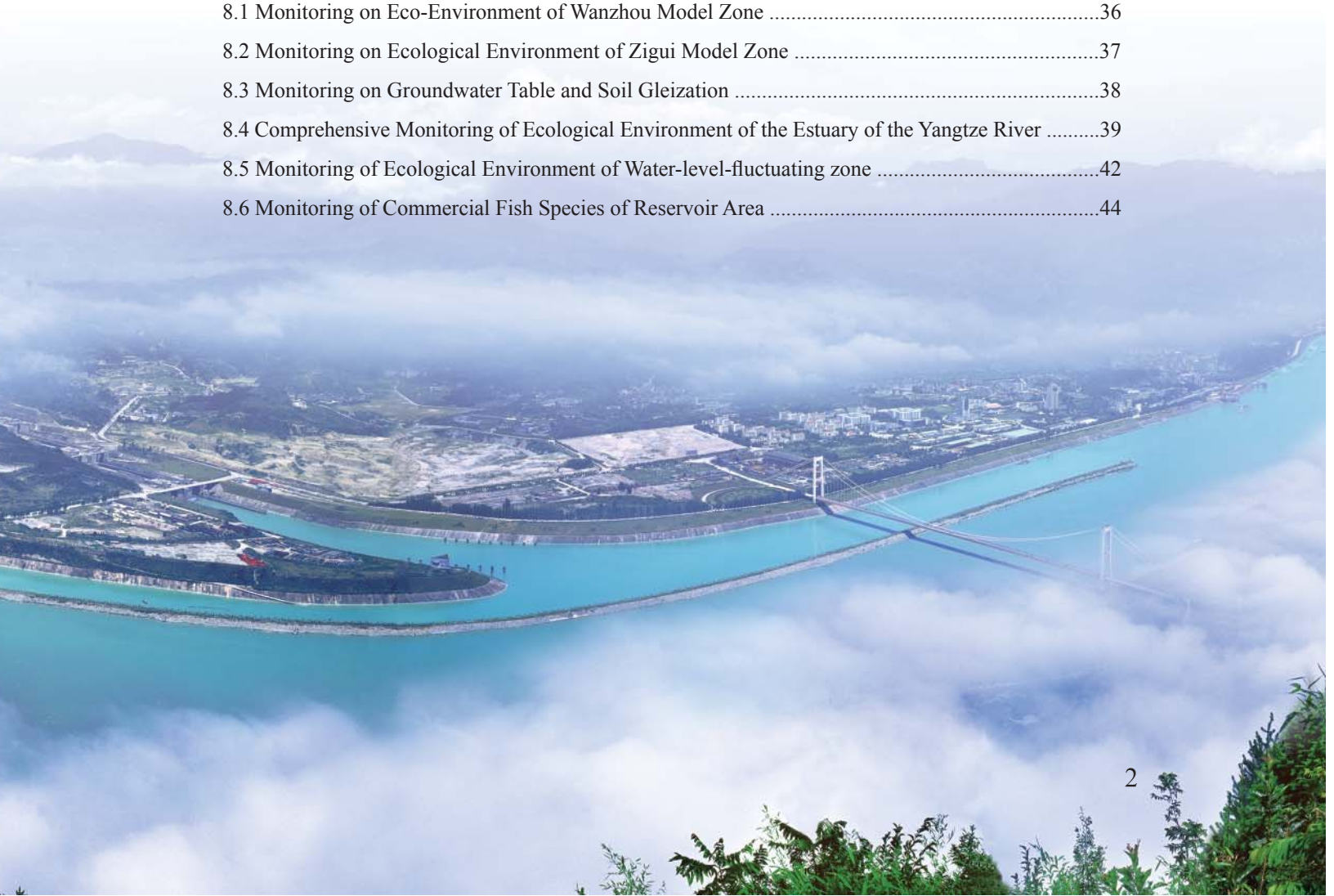
Content





Summary

2009 is the last year of construction in the primary design period of the Three Gorges Project and the year when the Three Gorges Project enters the period dominated by operation. The dispatch of water control project of the Three Gorges Dam enjoyed continuous and obvious improvement with flow peak reduction during flood period and water replenishment in dry period. The power plant achieved the designed output for the first time. In construction, the Three Gorges Project has achieved the management target of zero accident in both quality and safety and finished the construction of key water-control project of the year in an all round way.

In 2009, the Three Gorges Project facilitated the development of harmonious Dam areas with construction and completion of relevant projects one after another according to schedule. The activities such as the construction and operation of water-control project, as well as management of Dam areas had reached a new high.

In 2009, the annual average temperature of the Three Gorges Reservoir area was slightly higher than the historical average while annual precipitation was lower. The air temperature was abnormally higher in the winter than the historical average with big change in the spring. The precipitation was less in the autumn. The relative humidity, evaporation, annual wind speed and number of foggy days were lower than the historical average. It is the year with weakest acid rain since 1999. Both the frequency and intensity of earthquake from head to central parts of the Three Gorges Reservoir area had some reduction compared with that of 2008. The epicenters were mainly concentrated on the Badong-Zigui zone along the Yangtze River with very slight and slight earthquake in dominance. The monitoring and early warning of geological disasters enjoyed smooth progress.

In 2009, there were 209647 ha arable land and 574118 ha forest land in the Three Gorges Reservoir area respectively. The total sown area of crops was 541988 ha, and agriculture was dominated by grain crops. The

total application amount was 160,000 t for fertilizers and 699.4 t for pesticide and their loss was 14272 t and 45.6 t respectively.

In 2009, the fry flow of the "four major home fishes" at Jianli section downstream the Three Gorges Dam had some reduction in 2009. The total catch of *Coilia mystus* in the estuary of the Yangtze River during catch period was 62.0 t, down by 72.8% compared with that of 2008. The total catch of parent crabs and eel fry was 13.2 t and 8.1 t, up by 20.4% and 100.3% respectively compared with that of last year.

In 2009, the overall environmental quality of the construction areas and resettlement areas of the Three Gorges Project was good. The total discharge amount of industrial effluent from industrial sources in the Three Gorges Project area was 486 million t, among them, the discharge was 75700 t for COD and 5700 t for ammonia nitrogen. The amount of urban sewage reached 623 million t, among them, the discharge of COD and ammonia nitrogen was 87,700 t and 13000 t respectively. The generated amount of oil-containing waste water from ships was 413,000 t, 95.6% of them were under treatment and 82.6% of the discharged waste water met the standard. The annual generated amount of ship domestic sewage was 3.997 million t.

The water quality of the mainstream of the Yangtze River in the Three Gorges Reservoir area was Grade II~III in 2009 with Grade II in dominance. The water quality of Jialing River and Wujiang River, which are relatively big tributary of the Yangtze River reached Grade I~II national surface water quality standard. The percent of river sections in main primary tributaries met Grade I~III water quality standard was 76.8~96.4% during March~October of 2009 with major pollutants being permanganate value, ammonia nitrogen and BOD_5, better than that of last year but still with the occurrence of water bloom in some tributaries.

Chapter 1
Progress of the Three Gorges Project

2009 is the last year for the Three Gorges Project entering the primary designed construction period and the year dominated by operation. The Three Gorges Project has met the management target of zero accidents in both quality of construction projects and safety, and the annual construction of the Three Gorges water-control project had been finished in an all round way. The control of water resources by the Three Gorges water-control project has been under continuous improvement with evident achievement of reduction of flood peak flow during wet season and water replenishment during dry season. The hydropower station reached the designed capacity for the first time, the trial impoundment at the end of wet season reached 171.4 meters. The cargo shipment amount passing the Three Gorges Dam has kept fast growth for the sixth consecutive year.

In 2009, the Three Gorges Reservoir achieved optimum dispatch such as bigger change of water level and advance impoundment before the end of wet season. The incoming flow of the Three Gorges Reservoir during wet season was 12.5% less than the historical average. Measures such as advance impoundment and control the outflow have ensured flood control and appropriate use of water resources in the mid and lower reaches of the Yangtze River and facilitated the achievement of comprehensive benefits of the huge project. The annual generated electricity of the cascade hydropower stations in Three Gorges—Gezhouba Dam section was 96.1 billion kW•h, the maximum output of Three Gorges Dam power plant reached the designed output 18.2 million kW•h for the first time on August 8, safe and steady operation of the generating units of the Three Gorges Dam under full load has been subject to testing. The technical indicators of operation of the Three Gorges Dam ship lock met the design requirement, achieving the overall objective of "safe, orderly, highly efficient and smooth" put forward by the State Council. A total of 74.26 million t cargo passed the ship lock in 2009.

In 2009, the construction of Three Gorges Project achieved the management target of zero quality accident with 100.0% projects meeting the quality requirement and 92.6% being excellent or good quality. The on-going projects of underground power station and ship lifting facilities enjoyed smooth progress with completion of 262000 m^3 of concrete pouring, 2453 t of metal structure and electronic machine buried and installed, 7549 t of generator sets installed and 11210 m of consolidation & grouting during 2009.

In 2009, guided by the outlook on scientific development, relevant authorities had facilitated the construction and operation of the Three Gorges Project as well as development of harmonious Dam areas in an all round way. Projects including water & soil conservation have been constructed and completed one after another in accordance with the plan. The project construction, operation of water-control project, and management of Dam areas have reached a new high.

Chapter 2
Economic and Social Development

2.1 Climate

In 2009, the average air temperature of the Three Gorges Project area was higher than the historical average with annual precipitation less than the historical average. To be specific, the temperature in winter was higher than that of normal years with the occurrance of warm winter. There was big change of air temperature in the spring and staged high temperature in the summer. The precipitation was slightly higher in the spring but reduction in other three seasons compared with that of same period of the historical average. The relatively humidity, evaporation and wind speed in the Three Gorges Reservoir areas were slightly less than the historical average. The amount of heavy fog days was less than the historical average. Acid rain was lighter than that of the last year, the weakest since 1999. The meteorological disasters in the Three Gorges Reservoir areas included storms, staged high temperature, floods, drought and strong convective weather like gales and hails in the summer; and heavy fogs, snow and rainy days in the autumn.

Table 2–1 Monitoring results of meteorological elements of each station in the Three Gorges Project areas in 2009

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	19.0	1198.9	1128.3	80	1.4	943.9	23	27
Changshou	18.2	1080.9	851.4	79	1.1	1114.2	64	23
Fuling	18.6	1048.5	1235.5	81	0.8	1119.6	50	27
Fengdu	18.8	832.8	1040.9	78	1.3	1200.8	43	26
Zhong County	18.3	968.0	1114.5	78	1.2	1153.9	52	32
Wanzhou	18.8	1150.5	1330.6	80	0.8	1133.4	27	23
Yunyang	18.7	1221.1	1271.4	76	1.1	1218.0	6	22
Fengjie	18.6	1000.8	1276.9	73	1.4	1445.6	10	23
Wushan	19.0	866.6	1328.0	67	0.5	1436.9	7	25
Badong	17.6	882.4	1526.7	74	1.6	1284.5	43	27
Zigui	16.5	1224.1	1078.9	78	1.0	1468.2	4	41
Bahekou	17.2	944.6	1183.2	76	1.4	987.5	1	29
Yichang	17.4	1296.2	1375.0	74	1.3	1152.1	27	42

The annual precipitation of the Three Gorges Reservoir area was 832.8~1296.2 mm with relatively big spatial distribution of difference. The precipitation was big in Yichang (head of the Three Gorges Reservoir area) and central and western part of the Three Gorges Reservoir areas and small in Fengdu and eastern part with maximum of 1296.2 mm in Yichang; minimum at 832.8mm in Fengdu. The precipitation of Fengdu, Zhong County, Wushan and Badong was 18.0~21.1% less compared with that of historical average with the biggest reduction at 21.1% in Fengdu. The precipitation of other areas was basically same as the historical average. In time distribution, the precipitation was more in the spring but less in other three seasons compared with that of historical average of the same period. The reduction of precipitation was most obvious in the

autumn at 22.0%. The precipitation of June and August was 16.0~35.0% more than the same period of normal years, the precipitation was 24.5~52.4% less in July, October, November and December; while the monthly precipitation of other months was similar to the historical average.

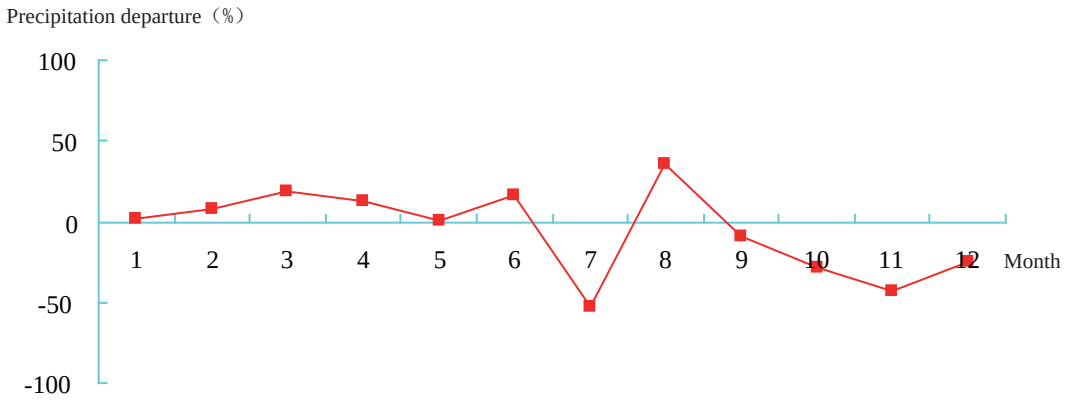


Figure 2–1 Change of the departure percent of monthly average precipitation of the Three Gorges Project area in 2009

The average air temperature of the Three Gorges Project areas in 2009 was 18.3℃ with 0.4℃ higher than the historical average. The average air temperature has been higher than the historical average for the ninth consecutive years since 2001, same as the trend of annual temperature change in Southwest China. In spatial distribution, the average air temperature of each area was higher than the historical average with western part being the most obvious. Among western part of Three Gorges Reservoir area, the rise was 0.2℃ higher in Yunyang and Zhong County; 0.8℃ higher in Wushan and Changshou and 0.3~0.6℃ higher in the rest monitoring stations. In time distribution, the air temperature was abnormally high during the winter with big change in the spring and autumn with frequent cold are in the winter. The lowest average air temperature in January was at 7.0℃ and highest average air temperature in July was 28.6℃. The average air temperature in the Three Gorges Reservoir areas in May and November was 0.6℃ and 1.6℃ lower compared with the same period of normal years. The average monthly temperature in other months was similar to or higher than the historical average of the same period with 1.0℃ higher during February, March and September.

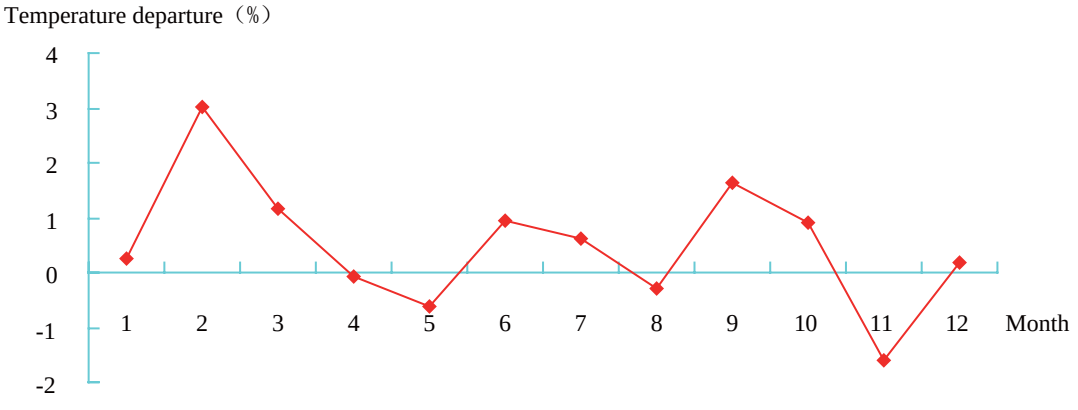


Figure 2–2 Change of the departure of monthly average temperature of the Three Gorges Project area in 2009

The annual average wind speed in the reservoir areas was 1.1m/s, same as that of last year but 0.2m/s less than the historical average. The maximum average monthly average wind speed of the reservoir areas was 1.3m/s in January. The minimum at 0.9 m/s in October. Among all representative monitoring stations, the average wind speed in Wushan, Fuling and Wanzhou was 0.4m/s, 0.8 m/s and 0.8m/s respectively, while the average wind speed of other monitoring stations was over 1.0 m/s with the maximum of 1.6m/s in Badong.

The annual average amount of foggy days in the reservoir areas was 30, 8 days less than the historical average and 3 days more than that of last year. It was the 8th consecutive year of less foggy days since 2002. The western part of the Three Gorges reservoir areas had clearly more foggy days than that of the eastern part with the most in Changshou at 64 days and the least in Zigui at 4 days. The amount of foggy days dropped in eastern part but went up in the western part with big local change but small overall change compared with that of last year. There were 4~6 more foggy days in the central part compared with the historical average. The amount of foggy days was similar to the historical average in Yunyang but less than the historical average in the remaining monitoring sites. The drop was quite obvious in Wanzhou, Chongqing and Fuling with reduction at 26, 22 and 22 days respectively.

The annual average of relative humidity of the Three Gorges Reservoir areas was 76%, same as that of 2008 and similar to the historical average. In spatial distribution, the relative humidity of western part was bigger than that of eastern part. The annual average relative humidity was 77~80% from Chongqing to Wanzhou with the highest in Fuling, 66~78% from Wanzhou to Yichang with the lowest in Wushan. The relatively humidity of the Three Gorges Reservoir areas was 76% in the spring, 74% in summer, 77% in the autumn and 77% in the winter with small seasonal difference. There was no significant change of the annual average relative humidity in the Three Gorges Reservoir area with 5% less in the spring compared with that of last year. The annual average relative humidity of each monitoring station was similar to or less than the historical average with change less than 3%.

The average evaporation of the reservoir area was 1213.2 mm in 2009 slightly less than that of last year and the historical average. In spatial distribution, the annual average evaporation was 1235.5mm in Fuling and less than 1200.0 mm in the areas west to Wanzhou with the lowest at 851.4 mm in Changshou. The annual average evaporation was 1200.0~1500.0 mm in all areas east to Wanzhou including Wanzhou with the maximum at 1526.7 mm in Badong. The annual average evaporation was more in western part but less in eastern part compared with the historical average. There was 100.0~200.0 mm more evaporation in the areas west to Wanzhou including Wanzhou with the maximum of 305.4 mm in Wanzhou, but 50.0~100.0 mm less in all areas east to Wanzhou. There was relatively big seasonal change of evaporation in the Three Gorges Reservoir areas in 2009. The average evaporation in the winter, spring, autumn and summer was 121.9mm, 286.0 mm, 295.9 mm and 493.9 mm respectively, down by 3.9mm, 52.4mm, 56.5 mm and 9.5 mm compared with that of same period of normal years.

The annual average pH of the precipitation of six acid rain monitoring stations in Chongqing, Fuling, Wanzhou, Fengjie, Badong and Yichang was 4.95, belonging to ordinary acid rain, slightly lighter than that of 2008. Winter was the season with the heaviest acid rain, followed by the spring, autumn and summer. Yichang was subject to relatively strong acid rain, Chongqing, Fuling, Wanzhou, Fengjie and Badong were subject to general acid rain. The acid rain was worsened in Chongqing, Wanzhou, Fengjie but became somewhat better in Fuling, Badong and Yichang compared with that of last year. 2009 is the year with the slightest acid rain pollution since 1999.

In 2009, the main meteorological disasters in the Three Gorges reservoir and neighboring areas were storms, floods and strong convective weather like gales and hails in the summer and drought in late summer and early autumn. There were other meteorological disasters such as heavy fogs and snows.

Storms and floods: There were frequent strong storms in Chongqing in 2009 with 6 regional-level storms and flood disasters from mid April to late September. A total

of 6.301 million people were subject to floods, leading to 31 deaths, 8 missing with direct economic loss of 3.05 billion yuan, about 690 million yuan were loss in agriculture.

There were 8 storms in Hubei Province in 2009. The storm during June 27-30 caused the most serious losses, at least 64 counties (cities or districts) of 17 cities (prefectures) suffered from the storm at different degree, affecting 6.423 million people with 13 deaths, 2 missing and direct economic loss of 1.51 billion yuan. The storms triggered floods, damage or even collapses of houses in hilly areas; difficulty in water drainage; spill of fish ponds, water logging of some low crop fields; which imposed significant damage to cotton, rice, maize, vegetables, melons, fruits and tobacco.

Drought: High temperature days occurred in the Three Gorges Reservoir areas in the summer and autumn of 2009 with droughts in the summer and autumn, affecting 1.381 million people, 569000 people had difficult access to drinking water; 98000 ha crops suffered from the disaster, 16000 ha subject to the disaster, 5000 ha having no yield with direct economic loss of 260 million yuan, 210 million yuan of them were loss in agriculture. The precipitation of most areas of Hubei Province was less during July and August, there was no rainfall in central and eastern part during August 1-26, 42 counties (cities or districts) of 8 cities including Enshi, Yichang, Suizhou, Xiaogan, Jingmen, Xiangfan, Huanggang and Jingzhou suffered from drought disaster, 6.386 million people were affected by drought, 350 people resettled in emergency; 588000 ha crops were subject to droughts with direct economic loss of 880 million yuan.

Gale and hail: In 2009, strong convective weather including gales and hails occurred in the Three Gorges Reservoir areas and surrounding regions from the spring to summer with serious damages. 13 counties (cities or districts) of Shiyan, Yichang, Xiangfan, Enshi and Shennongjia of Hubei Province suffered from gale and hail disaster during April 15~16, affecting 282000 people with one death, 4223 people resettled, 15000 houses damaged and direct economic loss of 100 million yuan.

Heavy fog: Heavy fogs occurred in autumn and winter in the Three Gorges Reservoir areas in 2009. The first heavy fog in the autumn of 2009 in Chongqing occurred during October 25–26, which was the widest and heaviest fog in 2009. There were a total 122 reports on traffic accidents in the municipality due to the fog, leading to delay of many flights in Jiangbei International Airport, up to 8:00 of October 27, a total of 130 departure flights were delayed or canceled, 41 incoming flights landed at reserve airports or returned, over 10,000 passengers were held up in the airport. On December 1, Xiangjing Expressway had less than 10 m visibility and closed for 8 hours, leading to stagnation of many passing vehicles. At 5:00 of that day, the visibility of Qianjiang section and Jingzhou section of Shanghai-Chongqing Expressway went down to 80 m. Up to early morning of December 3, Beijing-Hong Kong-Macao Expressway, Yihuang Expressway and Daqing-Guangzhou Expressway closed for 6~7 hours, Wuhan-Huangshi Expressway closed for 3 hours with nearly 10,000 vehicles stayed on roads.

Snow: Snow disaster occurred in many areas of the Three Gorges Reservoir regions at different degrees in early spring, late autumn and winter of 2009, imposing serious influence on local agricultural production and everyday life. Wanzhou in Chongqing was hit by snow during March 11~12, 123000 people in 10 towns and townships suffered from the snow, 16000 people had difficult access to drinking water, 3267 ha crops suffered from the snow, 106 building collapsed, 1002 buildings damaged with direct economic loss of 41 million yuan. The mountain areas of four counties and cities of Hubei Province including Enshi, Lichuan, Jianshi and Xianfeng had 6~10 cm snow during April 1-2, 414000 people in 27 towns and townships suffered from the snow, 17 buildings collapsed, 33 buildings damaged, 25000 ha crop field were affected, 2273.0 ha had no yield at all with direct economic loss of 82.32 million yuan, 76.20 million yuan of them were loss in agriculture. The average depth of snow in mountain areas such as Yiling, Zigui and Xingshan of Yichang City was 8 cm during April 2~3 with 10 cm in some areas; leading to break or lodge of rape and wheat, freezing of potato spouts and tea trees; 6548.7 ha crop field were subject to loss in some parts of Yichang, 643.3 ha of them had no yield at all; economic loss in agriculture was 23.35 million yuan.

2.2 Terrestrial Plants

In 2009, the investigations on the vegetation of water-fluctuation-zone in the Three Gorges Reservoir area showed that the vegetation was dominated by shrubbery and thick grass. The dominating shrub species included *Ficus tikoua, Pterocarya stenoptera, Broussonetia papyrifera, Vitex negundo, Coriaria nepalensis, Rosa cymosa*, and *Rhus chinensis*. The dominating herb species included *Imperata cylindrica var.major, Xanthium sibiricum, Pueraria lobata, Setaria viridis, Cynodon dactylon, Eclipta prostrata, Digitaria ciliaris, Hemarthria altissima* and *Capillipedium assimile* etc.

Chrysolophus pictus (golden pheasant)

42 types of plant communities were in the water-fluctuation-zone, 14 of them are shrubberies, mainly including *Form. Pterocarya stenoptera + Vitex negundo, Form. Vitex negundo, Form. Coriaria nepalensis + Rhus chinensis), Form. Rubus sp + Ligustrum henryi* and so on, which were mainly distributed in the zone over 173 meters, which have not been waterlogged. There were 28 types of grass communities, they were mainly Form. Imperata cylindrica var. major, *Form. Xanthium sibiricum, Form. Setaria viridis, Form. Setaria viridis + Artemisia annus, Form. Cynodon dactylon, Form. Alternanthera philoxeroides, Form. Digitaria ciliaris, Form. Hemarthria altissima, and Form. Capillipedium assimile* etc., these grass communities were mainly distributed in waterlogged zones (below 173 m).

The monitoring results of satellite remote sensing of the ecology and environment of the water-fluctuation zone of the Three Gorges Reservoir areas show rapid restoration of vegetation of water-fluctuation zone after drop of water level during 2008-2009. The maximum average vegetation coverage in water-fluctuation zone was 68.0%. The restoration of vegetation was good in the water-fluctuation zone with relatively small slope but poor in water-fluctuation zone with slope over 30°.

2.3 Terrestrial Animals

Up to the end of 2009, there were a total of 692 species of 335 genuses of 109 families in 30 orders of 4 classes wild terrestrial vertebrates in the Three Gorges Reservoir areas，Among them, 112 species were animals, 485 were bird species, 51 reptile species and 44 amphibious species. 15 species were Grade I wildlife and 78 species were Grade II wildlife under national key protection program, totaling 93 species; 70 species were only found in China; 43 unique species were mainly distributed in China, totaling 113. The total amount of species either under national key protection program or unique in China was 195.

The findings of the investigation on winter water birds in the Three Gorges Project area in winter of 2009 showed obvious reduction of the population of over-winter water birds in the mainstream of the Yangtze River (the section from Chaotianmen of Chongqing to Three Gorges Dam) after trial impoundment compared with the same period of last year, these birds mainly were distributed in Chaotianmen-Yunyang section.

The findings show that the change of both species and population of most over-winter water birds in 12 primary tributaries of the Yangtze River was not obvious. There was evident increase of the population of over-winter water birds in the Xiaojiang River from Yunyang to Kai County, which were mainly distributed in the waters upstream the dam in Kai County. A total of 1118 over-water birds (16 species) were observed in 2009, down by 16.1% compared with the same period of 2008. 3292 such birds were observed in 2010, up by 194.5% compared with that of 2009.

248 *Fulica atra* (living on aquatic plants) were observed in Xiaojiang River in 2009, up by 125.5%

Chrysolophus pictus (golden pheasant)

compared with that of 2008. Its population went beyond 1,000 in 2010, up by 303.2% compared with that of 2009. Three Fulica atra were observed at Fengdu-Zhong County section of the mainstream of the Yangtze River in January of 2010, it was firstly found living through winter in the mainstream of the Yangtze River in 1996 when baseline investigation and monitoring began in the Three Gorges Reservoir areas.

In all over-winter water birds, the observed population of mandarin ducks (*Aix galericulata*) (under Grade II national conservation program) in 2010 went up by 33.7% compared with that of 2009, they were distributed in all primary rivers of the Yangtze River under the investigation with the highest population in Wujiang River, followed by Daning River and Xiangxi River.

Mergus squamatus was observed in Tengzigou Reservoir, Qiaotou Town of Shizhu Tujia Autonomous County on February 8, 2010, scale stripes at two sides of the water bird were observed which is different from *M. merganser*. As an endangered species, *Mergus squamatus* has small population (about 1200 pairs in the world) and narrow distribution area with its breeding sites only in Northeast China and Far East Region of Russia and its population in China was 200~250 pairs, belonging to Grade I wildlife under key national protection program.

2.4 Fishery Resources and Environment

2.4.1 Fishery resources

In 2009, the total catch of natural fish in the Three Gorges Reservoir waters, waters downstream the huge dam, Dongting Lake, Poyang Lake and estuary was 46600 t, down by 20.1% compared with that of 2008. The fry flow of the four major native (home) fishes at Jianli monitoring section downstream the Dam were 42 million tails, the fry fishing season was not obvious. The population of eel fry and Chinese turtle crab (parent crab) in the estuary went up at different degree, but the population of *Coilia mystus* kept on declining.

● **Reservoir area**

The total catch of natural fish in the reservoir area was 3329 t in 2009, up by 24.7% compared with that of 2008. Based on the composition of the catch, it was estimated that there was 624 t of bronze gudgeon (*Coreius heterodon*), 923 t of catfish, 544 t of carp, 286 t of largemouth bronze gudgeon (*Coreius guichenoti*), 129 t of grass carp and 119 t of yellow catfish (P*elteobagus fulvidraco*).

The above 6 fish species took up 78.8% of the total catch and were main commercial fish species in the reservoir areas.

● **Downstream section**

The total catch of natural fish in the downstream section of the Three Gorges Dam reached 1270 t in 2009, down by 3.6% compared with that of 2008. Based on the composition of the catch, it was estimated that there was 331 t of carp, 206 t of bronze gudgeon, 118 t of bream, 95 t of "four major home fishes", 67 t of catfish and 54 t of yellow catfish.

Among the catch, bronze gudgeon, carp, bream, "four major home fishes", catfish and yellow catfish took up 68.6% and were main commercial fish species.

● **Spawning site of the "Four Major Home Fishes"**

The fry flow of the "four major home fishes" at Jianli section downstream the Dam was 42 million tails during May~July of 2009, down by 76.9% compared with that of last year, 1.7% of the average of 1997-2002 when there was no impoundment. The fry flow process of the "four major home fishes" was not quite obvious and kept on relatively low level.

The "four major home fishes" was still dominated by

silver carp, taking up 80.5%; followed by grass carp, taking up 17.3%; variegated carp and black carp ranked the third and fourth, taking up 2.1% and 0.1%.

● **Dongting Lake**

The total catch of natural fish in the Dongting Lake was 18400 t in 2009, down by 11.5% compared with that of 2008. Among them, the capture was 8400 t in the east Dongting Lake, 6000 t in the south Dongting Lake, 4000 t in the west Dongting Lake, accounting for 45.7%, 32.6% and 21.7% of the total respectively.

Among the catch, local species of carp, crucian carp and catfish and the "four major home fishes" took up 69.4% and were major commercial fish species in the Dongting Lake.

● **Poyang Lake**

The total catch of natural fish in the Poyang Lake was 23500 t in 2009, down by 29.4% compared with that of 2008. The dominating species were local fishes like carp, catfish, yellow catfish, crucian carp, and the "four major home fishes", they took up 75.9% of the total catch.

● **Estuary area**

The amount of issued license for catch of *Coilia mystus* and eel fry for the operation in estuary waters in 2009 was evidently less than that of 2008, down by 52.6% and 26.0% respectively; the amount of crab catch ships was similar to that of 2008. The catch time for Coilia mystus was May 1~June 27 with total catch of 62.0 t, down by 72.8% compared with the same period of 2008. The catch time of parent crabs and eel fry was November 6~December 23 and January 2~April 15 respectively with total catch of 13.2 t and 8.1 t respectively, up by 20.4% and 100.3% compared with the same period of last year.

2.4.2 Fishery environment

The water quality of 7 important fishery waters (Yibin, Banan, Wanzhou, Jingzhou, Yueyang, lake mouth and estuary area) of the mainstream of the Yangtze River, Dongting Lake, Poyang Lake and estuary of the Yangtze River was monitored in 2009. The assessment of water quality complies with Fishery Water Quality Standard (GB11607-89). The unmentioned items would be assessed according to corresponding water function class specified in the Water Quality Standard for Surface Water (GB3838-2002). Monitoring data showed that the water quality of important fishery waters of the Yangtze River basin in 2009 basically met fish growth and reproduction requirements. Some waters were still subject to certain pollution with major pollutants being copper, total nitrogen and total phosphorus.

Copper concentration in fishery waters in Yibin which is the upper reaches of the Yangtze River went beyond standard during reproduction, growth and over-winter periods of fish. The concentration of TP went beyond standard during fish growth period. In Banan waters, copper concentration went beyond standard during reproduction, growth and over-winter periods; petroleum went beyond standard during fish reproduction and growth period. All monitoring items of waters in Wanzhou did not exceed the standard.

In waters of Zhicheng and Jingzhou, which are midstream of the Yangtze River, all monitoring items did not exceed the standard. The going-beyond-standard rate of TN in Chenglingji was 100.0% during fish over-winter, reproduction and growth periods. All monitoring items of Chinese sturgeon (*Acipenser sinensis*) spawning sites in Yichang and spawning sites of the "four major home fishes" did not exceed the standard during their reproduction period.

Copper concentration in the waters of lake mouth went beyond the limit during reproduction and growth periods of fish. Both lead and TN concentrations went beyond the limit during over-winter, reproduction and growth periods. Among them, the going-beyond-limit rate of lead was 66.7% in winter, 100.0% in reproduction period and 66.7% in growth period. The going-beyond-standard rate for TN was 100.0%. The going-beyond-standard rate for TP was 33.3% in winter and 100.0% in growth period.

The main pollutants in the Dongting Lake were TN, TP, non-ion ammonia, permanganate value and ammonia nitrogen. The concentration of TN and TP went beyond the standard during winter, reproduction period and growth period of fish. Among them, the going-beyond-standard rate of TN was 44.4% in winter, 100.0% in reproduction period and 88.9% in growth period.

The going-beyond-standard rate of TP was 44.4% in winter, 100.0% in reproduction period and 11.1% in growth period. Non-ion ammonia concentration and permanganate value went beyond the standard during over-winter and growth period. The going-beyond-standard rate of non-ion ammonia concentration was 33.3% during winter and 77.8% during growth period; the going-beyond-standard rate of permanganate value was 33.3% during winter and 100.0% during growth period; the going-beyond standard rate of ammonia nitrogen was 22.2% in winter.

Major pollutants in the Poyang Lake were lead, TN, TP, Cu and permanganate value. The concentrations of lead, TP and TN went beyond standard during winter, reproduction period and growth period. Among them, the going-beyond-standard rate of lead was 44.4% in winter, 100.0% in reproduction period and 33.3% in growth period. The going-beyond-standard rate of TP was 100.0% in winter, 55.6% in reproduction period and 33.3% in growth period. The going-beyond rate of TN was 100.0% in all periods. The going-beyond rate of copper was 100.0% in both reproduction and growth periods of fish. The going-beyond rate of permanganate value was 11.1% in winter.

Major water pollutants in waters of the estuary of the Yangtze River that went beyond standard were non-ion ammonia, volatile phenol, TN, and petroleum. Among them, the going-beyond-standard rate of non-ion ammonia was 8.3% during the catch period of eel. The going-beyond-standard rate of volatile phenol was 8.3% during catch period of Coilia mystus and 33.3% during catch period of crab in winter. The going-beyond-standard rate of TN was 100.0% during the catch period of eel, Coilia mystus and crabs. The going-beyond rate of petroleum was 25.0% during crab capture period in winter.

2.5 Unique Fish Species and Rare Aquatic Animals

2.5.1 Unique fish species in the upper reaches of the Yangtze River

Monitoring and investigation of fish resources were conducted at Yibin section of lower reach of the Jinsha River; Hejiang River, Mudong, Wanzhou and Zigui sections of the upper reaches and Yichang section of mid reaches of the Yangtze River in 2009 with a collection of 118 species of fish. Among them, 22 were unique species in the upper reach of the Yangtze River and 7 were alien species. The amount of fish species was the same with reduction of the peculiar fish species and rise of alien species compared with that of last year.

A total of 92590 tails of fish with total weight of 2017.52 kg were captured during the capture in the mid and upper reaches of the Yangtze River. Among them, 5274 tails with weight of 335.24 kg were unique species accounting for 5.7% of total tails and 16.6% of total weight, down by 49.9% and 24.5% compared with the same period of last year. The mass percent of unique fish species in Yibin and Hejiang sections upstream of the Three Gorges Reservoir dam was 38.8% and 29.6%, while the percent of fish amount of the two sections was 19.4% and 13.4% respectively with the most common fish species being *Coreius guichenoti, Rhinogobio ventralis, Rhinogobio cylindricus* and *Leptobotia elongata*. Among the catch in Mudong section at the end of the Three Gorges Reservoir, the mass percent of unique fish species was 35.6% and tail percent 13.5% with the common species of *Coreius guichenoti and Rhinogobio cylindricus*. Among the catch in Wanzhou section in the mid of Three Gorges Reservoir and Zigui section in the head of the Reservoir, only 6 kinds of unique fish species including *Procypris rabaudi, Megalobrama pellegrini, Acrossocheilus monticola*, *Ancherythroculter nigrocauda*, *Hemiculter tchangi* and *Rhinogobio cylindricus* were observed with quite low percent of both mass and amount.

2.5.2 Rare fish species

The sonar detection conducted on November 26 and December 1~2 of 2009 showed that Chinese sturgeon is distributed in the section of the Yangtze River from Dajiang Power Plant of Gezhouba to Yiling Bridge. The population of Chinese sturgeon was 72 tails during the spawning and 63 tails after spawning period, taking up 52.9% of that of last year. In general the population of Chinese sturgeon is on declining trend.

Judging on the distribution of the caught egg-hunting fish species that eat the eggs of Chinese sturgeon during the reproduction period of Chinese sturgeon, there was only one spawning during 2009 between midnight of

November 23 and early morning of November 24 at the river section of Gezhouba-Sanxia Pharmaceutical Manufacturer, there were about 9 female Chinese sturgeon producing eggs, 4 times of that of 2008. But its spawning scale is still at low level.

In 2009, there was two accidental catch of adult Chinese sturgeons in Jiangsu Province. There were still accidental catch of young Chinese sturgeons in the estuary of the Yangtze River. 19 tails of *Myxocyprinus asiaticus* were caught by accident, there was no accidental catch of *Psephuyrus gladius* and *Acipenser dabryanus*.

598 head•times of the Yangtze Finless Porpoise were observed in mid and lower reaches of the Yangtze River at such places as Tian'ezhou old course, Shishou section, Dongting Lake, Honghu Lake and Poyang Lake in 2009. Among them, high frequency of occurrence of the Yangtze Finless Porpoise was monitored in the Poyang Lake with daily average frequency of 97 head•times per day during the monitoring period. The average head•times of Yangtze Finless Porpoise per day at Shishou section was relatively small, while the population of Yangtze Finless Porpoise under human care in old river course of Tian'ezhou was encouraging. The investigation during March of 2008~June 2009 at the mainstream section of the Yangtze River from Wuhan to Shanghai found many "blank areas" of the Yangtze Finless Porpoise in the mid and lower reaches of the Yangtze River, indicating increasing fragmentation of the habitat of the Yangtze Finless Porpoise. The investigation during 2009 had found no white-flag dolphin (*Lipotes vexillifer*).

Chrysolophus pictus (golden pheasant)

2.6 Agricultural Ecology

2.6.1 Ecological environment of agricultural field

In 2009, the total area of arable land in the Three Gorges Reservoir areas was 209,647 ha with per capita arable land at 0.054 ha. There were 574,118 ha forest land, 73,142 ha orchard and 9093 ha tea plantation.

In arable land, 89695 ha were paddy field and 119952 ha were dry land, accounting for 42.8% and 57.2% respectively. Paddy field was dominated by double cropping, taking up 56.0%, 33.7% for one cropping and 10.3% for triple cropping. Dry land was dominated by triple cropping, taking up 57.1%, 35.7% for double cropping and 7.2% for one cropping.

The multiple crop index of arable land in the Three Gorges Project area was 258.5% in 2009. Total sown area was 541988 ha, 389411 ha of them were for grain crops and 152577 ha were for cash crops. The proportion of grain crops went down and that of cash crops increased compared with that of the last year.

In the arable land mix, the percent of arable land ranging from 10° to 15° and 15° to 25° was 30.6% and 31.7% of the total; the arable land with slope less than 10° and more than 25° accounted for 21.8% and 15.9% respectively. A total of 20404 ha cropland had restored to forest or grassland, 11095 ha slope land were turned into terraced fields.

2.6.2 Rural energy

The energy mix of agriculture in the Three Gorges Reservoir areas in 2009 was still dominated by direct combustion of firewood and straw. The output was 8.817 million t for firewood, 4.424 million t for straw, 11.869 million t for small coalpit and 96.516 million m^3 for biogas. In 2009, the biogas enjoyed good development in the Three Gorges Project area with 215,189 biogas pits, 16.7 pits per 100 households.

2.6.3 Crop disease and insect pest

With increase of arable land in the Three Gorges Reservoir area, the area of cropland subject to disease and insect pests and prevention and control measures rose in 2009. Among them, 394,200 ha•times were

subject to insect pests and 213,800 ha•times subject to plant disease. Insect pests for crops were dominated by rice borer, while crop diseases were dominated by rice blast and corn banded sclerotial blight.

A total of 375067 ha•times were under the prevention and control of insect pests and 210267 ha•times under the prevention and control of plant disease, taking up 95.1% and 98.3% respectively. There was 5.2 percentage points rise of prevention and control of rate of plant disease and 4.7 percentage points rise of prevention and control rate of insect pests compared with that of last year.

Table 2–2 Major crop disease and insect pests of the Three Gorges Project area in 2009

Type of crop disease and insect pests	Area affected (ha•times)	Area controlled (ha•times)	Loss saved (t)	Actual crop loss (t)
Rice borer	93533	112400	32153	6921
Rice blast	37200	30800	8668	3227
Corn leaf blight & spot	17267	15333	2515	696
Potato late disease	28533	21600	15811	11746
Corn banded sclerotial blight	38667	33267	6719	1449
Damage by rats	111533	95867	18657	14741

2.7 Geological Disasters

2.7.1 Earthquake

There were 1964 earthquakes at ML ≥ 0.0 from the head to the central part of the Three Gorges Project areas (East longitude 108°20'~112°00', north latitude 29°55'~31°45') during 2009, 157 less than that of 2008. Among them, 1144 earthquakes were at 0.0 ≤ML＜1.0, up by 32 cases compared with that of last year; 721 were quakes at 1.0≤ML＜2.0, down by 168; 92 quakes at 2.0 ≤ ML＜3.0, down by 13; 7 quakes at 3.0≤ML＜4.0, down by 7; no quake at 4.0≤ML＜5.0, down by 1. The strongest was ML3.3 earthquake in Badong County, Hubei Province occurred at 13:52, January 13, 2009.

In 2009, both the frequency and intensity of earthquakes in the region from the head to the central part of the Three Gorges Project areas had some reduction compared with that of 2008, which were mainly concentrated on Badong—Zigui areas along the

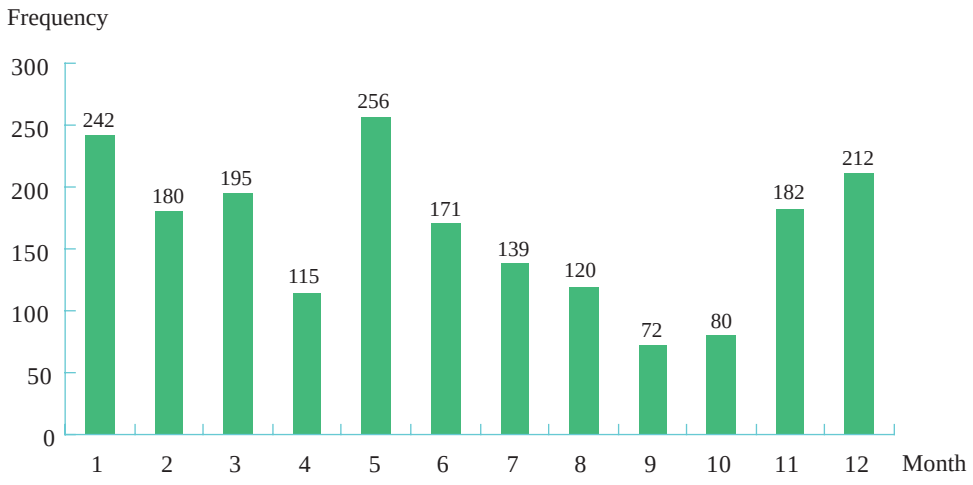


Figure 2–3 Frequency of earthquakes in the head to the central part of Three Gorges Project area in 2009

Yangtze River. These earthquakes were dominated by minor and very slight quakes with the extent having something to do with the rise and fall of water levels in the reservoir.

2.7.2 Collapse, landslide and mud-rock flow

In 2009, there were 3053 monitoring sites on collapses, landslides and bank stability, which were integrated in monitoring and early warning system of the Three Gorges Reservoir areas and basically covered all areas with existing geological risks such as collapses and landslides. Up to the end of 2009, the monitoring and early-warning system for geological disasters in the Three Gorges Reservoir areas had smooth operation and played an important role in protecting life and property in the areas and normal operation of the reservoir.

In 2009, a total of 3700 people were involved in monitoring and early-warning of geological disasters with 199,000 times of monitoring by the public and 44000 times of professional monitoring (27,000 times of them by GPS); 13000 times of monitoring on various kinds of boreholes; 3900 times inspection and submission of 2100 monitoring reports. As a result, 92 places were found with deformation and even high risks of collapses or landslides, 53 of them were new sites, 7 sites reached the warning criterion (orange), including Xizhou Shuping landslip in Shazhen of Zigui County; Gongjiafang hill collapse in Longjiang Village, Wuxia Town of Wushan County; Taping landslip in Quchi Township of Wushan County; Outang landslip and Tugouzidong landslip in Fengjie County; Liangshuijing landslip in Guling Town of Yunyang County; and Xinfangzi landslip in Nanzhu Village, Longkong Township of Fengdu County. Early warning was carried out to the potential collapse and landslips with high risks in time. The residents living near these high-risk sites were resettled under the guidance by local government and their lives and property were protected.

Chrysolophus pictus (golden pheasant)

Chrysolophus pictus (golden pheasant)

Chapter 3
Discharge of Pollution Sources

3.1 Discharge of industrial effluent

Environmental statistics of 2009 showed that the discharge of waste water from industrial sources in the Three Gorges Project area was 486 million t. Among them, 452 million t were in reservoir areas in Chongqing and 34 million t in reservoir areas of Hubei Province, accounting for 93.0% and 7.0% of the total respectively. In the discharged industrial effluent, the discharge of COD and ammonia nitrogen was 75,700 t and 5700 t respectively.

Table 3–1 Discharge of waste water from industrial pollution sources of the Three Gorges Project area in 2009

Region		Waste water (100 million t)	COD (1000 t)	Ammonia nitrogen (1000 t)
Reservoir area in Hubei		0.34	2.2	0.3
Reservoir area in Chongqing		4.52	73.5	5.4
Total		4.86	75.7	5.7
Among them	Chongqing City	2.39	37.4	2.7
	Changshou District	0.43	8.5	0.1
	Fuling District	0.49	12.7	1.5
	Wangzhou District	0.39	3.8	0.1

3.2 Discharge of Urban Sewage

3.2.1 Statistics of the discharge of urban sewage

The environmental statistic data in 2009 showed that the total discharge of sewage from cities and towns of the Three Gorges Project area (TGPA) was 623 million t. Among them, 596 million t were in Chongqing and 27 million t in Hubei Province, taking up 95.6% and 4.4% of the total urban sewage respectively. In the discharged urban domestic sewage, the amount of was 87700 t for COD and 13000 t for ammonia nitrogen.

There were 70 sewage treatment plants in cities and towns of the Three Gorges Project area with designed daily capacity at 1.9949 million t. A total of 558 million t waste water was treated, 548 million t of them were sewage, taking up 88.0% of the total amount of sewage.

3.2.2 Investigation on urban garbage

In 2009, there were 2.5848 million t of domestic garbage in cities and towns of the Three Gorges Project area, 2.1444 million t of them were disposed, taking up 82.6% of total amount of garbage; 450400 t were discharged in a non-concentrated way, accounting for 17.4%. Investigation findings of 14 garbage disposing facilities in the Three Gorges Project area showed that they all adopt landfill method except Tongxing Garbage Disposal Facility in Shapingba District, which utilized incineration technology. On the average, over 80.0% of urban garbage was collected.

Table 3–2 Discharge of urban sewage of the Three Gorges Project area in 2009

Area		Waste water (100 million t)	COD (1000 t)	Ammonia nitrogen (1000 t)
TGPA in Hubei		0.27	3.0	0.5
TGPA in Chongqing		5.96	84.7	12.5
TGPA		6.23	87.7	13.0
Among them	Chongqing City	4.28	53.3	8.8
	Changshou District	0.17	2.9	0.2
	Fuling District	0.29	2.9	0.5
	Wanzhou District	0.36	10.2	1.0

Table 3–3 Urban sewage treatment plant of the Three Gorges Reservoir area in 2008

Area	Amount of sewage treatment plant	Design capacity (1000 t/d)	Annual treatment amount (100 million t)
TGPA in Hubei	14	115.1	0.25
TGPA in Chongqing	56	1879.8	5.33
Total	70	1994.9	5.58

Table 3–4 Urban domestic garbage of the Three Gorges Reservoir area in 2008

Area	Urban permanent population (10000)	Domestic garbage (10000 t)	Disposed amount (10000 t)	Scattered discharge (10000 t/y)
Jiangjin City	16.64	6.07	4.92	1.15
Banan Dist.	22.20	8.11	6.58	1.53
Six districts	416.10	151.87	125.50	26.37
Changshou District	29.80	10.87	9.28	1.59
Fuling District	43.97	16.05	13.13	2.92
Fengdu County	14.20	5.17	4.10	1.07
Zhong County	10.92	3.99	3.34	0.65
Wanzhou	83.86	30.61	24.65	5.96
Yunyang County	28.30	10.33	9.09	1.24
Fengjie County	19.62	7.16	6.15	1.01
Wushan County	9.22	3.37	2.79	0.58
Badong County	6.50	2.37	1.90	0.47
Zigui County	9.60	3.51	3.01	0.50
Total	710.93	259.48	214.44	45.04

Note: Six districts include Dadukou District, Shapingba District, Jiulongpo District, Yuzhong District, Nan'an District and Jiangbei District.

3.3 Pesticides and Fertilizers

In 2009, the total applied amount of fertilizer and pesticides in 19 districts (counties) of the Three Gorges Project area had some rise. The per-unit-application of fertilizer was similar to that of last year and the per-unit-application of pesticides had some increase. In general, there was still the imbalanced application of fertilizers and pesticides.

3.3.1 Fertilizer

A total of160,000 t fertilizer (pure) were applied in the Three Gorges Reservoir area during 2009. Among them, 100,000 t were nitrogen fertilizer, 46000 t were phosphorus fertilizer and 14000 t potash fertilizer, accounting for 62.5%, 28.8% and 8.7% of the total. The application amount of pure fertilizer per hectare was 0.75 t, basically same as that of the last year. Among all districts (counties), the biggest user of fertilizers (pure) was Yunyang County and Wushan County.

Total drain of fertilizer in the Three Gorges Reservoir areas was 14272 t. Among them, 11098 t were nitrogen fertilizer, 2476 t were phosphorus fertilizer and 698 t potassium fertilizer, taking up 77.8%, 17.3% and 4.9% of the total loss respectively. In terms of the loss per unit area, Banan District had the highest loss at 0.18 t/ha; followed by Yiling at 0.15 t/ha. The average fertilizer loss per unit area was 0.07 t/ha.

3.3.2 Pesticides

A total of 699.4 t pesticides (pure equivalent) were applied in the Three Gorges Reservoir areas in 2009. Among them, 344.2 t were organophosphorus pesticides, 157.8 t were organic nitrogen pesticides, 66.9 t were pyrethroids, 78.4 t herbicides, and 52.1 t other kinds of pesticides, accounting for 49.2%, 22.6%, 9.6%, 11.2% and 7.4% of the total respectively.

The total loss of pesticides in the Three Gorges Reservoir areas was 45.6 t. Among them, 27.7 t were organophosphorus pesticides, 7.9 t organic nitrogen pesticides, 3.4 t pyrethroids, 3.9 t herbicides, 2.7 t other kinds of pesticides, taking up 60.7%, 17.3%, 7.5%, 8.6% and 5.9% of the total respectively. All districts (counties), Fuling had the biggest loss of pesticides, followed by Yunyang County and Zigui County.

3.4 Discharge of Ship Pollutants

There were near 8400 registered ships in the reservoir areas in 2009, 6466 of them were motorboats. Both the total amount and tonnage of ships had some increase compared with that of last year but no obvious change of the amount of motorboats. Ships in use continuously became more standardized, bigger and in series, which optimized the transportation structure and increased the safety. There was further rise of the automation on the monitoring and management of these ships.

3.4.1 Ship transportation

In 2009, a total of 60.88 million t of cargo passed the lock, up by 11.4% compared with that of 2008. The total annual port cargo capacity of main ports with certain scale in the Three Gorges Project area was 83.74 million t, up by 35.2%. The passenger transport volume of navigation in ports of Chongqing Municipality (taking Chongqing and Wanzhou as example) was 5.54 million people•times, up by 24.8% compared with that of last year.

3.4.2 Oil-containing waste water from ships

In 2009, inspectors checked water pollution of 376 ships caused by oil-containing waste water from engine room, taking up 5.8% of the total amount of registered autoships in the Three Gorges Project area. Among them, 286 ships (76.1%) met national pollution discharge standard, the meet-the-standard rate went up by 2.3% compared with that of 2008. Among all types of ships, the discharge of oil-containing waste water of 100.0% tourist ships, 82.0% towboat, 82.0% other kind of ships, 74.0% passenger ships, 73.0% cargo ships met national waste water discharge standard. The meet-the-standard rate of passenger ships and towboat had some reduction while that of tourist ships, other kind of ships and cargo ships had some increase compared with that of last year. The overall meet-the-standard rate of cargo ships was still the lowest. Judging from the power of all kind of ships, the up-to-the-standard rate of the ship with power ≥220kW was about 30% higher than that of the ship with power ＜220 kW.

In 2009, there were about 6466 ships navigating the Three Gorges Reservoir waters which generated oil-containing waste water. The generated amount of oil-containing waste water from ships was 413,000

t, 395,000 t of which were treated, taking up 95.6%. After the treatment, 326,000 t of waste water meeting national pollution discharge standard were discharged with the up-to-the-standard rate at 82.6%. Compared with that of last year, there was 1000 t increase of generated amount of oil-containing waste water, no obvious change in treatment rate and about 4.9% reduction of up-to-the-standard rate in waste water discharge. The rank of generating amount of oil-containing waste water from various ships had some difference compared with that of the last year: 197000 t from cargo ships, 161000 t from passenger ships, 32000 t from other kinds of ships, 19,000 t from towboat, 5000 t from tourist ships, accounting for 47.6%, 38.9%, 7.7%, 4.6% and 1.2% of the total. The up-to-the-standard rate of discharge of oil-containing waste water was 74.0% for cargo ship, 82.3% for tourist ship, 90.0% for passenger ships, 91.0% for township and 92.0% for other kind of ships.

Among the discharged oil-containing waste water, the discharge of petroleum was 37.4 t, down by 0.4 t compared with that of last year. Among various ships, petroleum discharge from high to low was 20.9 t for passenger ships, 14.8 t for cargo ships, 1.4 t for other kinds of ship, 0.2 t for towboat, 0.1 t for tourist ship, accounting for 55.9%, 39.7%, 3.6%, 0.5% and 0.3% of the total respectively.

Table 3–5 Discharge of oil–containing waste water from ships in the Three Gorges Reservoir area in 2009

Ship		Oil-containing waste water						Petroleum	
Type	Amount	Generated amount (10,000 t)	Percent (%)	Treatment amount (10000 t)	Treatment rate(%)	Amount meeting standard (10,000 t)	Meeting standard rate (%)	Discharge (t)	Percent (%)
Tourist ship	59	0.5	1.2	0.5	100.0	0.4	82.3	0.1	0.3
Passenger ship	2219	16.1	38.9	15.4	96.0	13. 9	90.0	20.9	55.9
Cargo ship	2913	19.7	47.6	18.5	94.0	13.7	74.0	14.8	39.7
Towboat	245	1.9	4.6	1.9	100.0	1.7	91.0	0.2	0.5
Others	1030	3.2	7.7	3.2	100.0	2.9	92.0	1.4	3.6
Total	6466	41.3	100.0	39.5	95.6	32.6	82.6	37.4	100.0

3.4.3 Ship sewage

In 2009, 50 ships in the Three Gorges Project waters were investigated on the discharge of domestic sewage. Among them, the sewage of 20 ships was treated before discharge with the concentrations of suspended substances, BOD and E-coli meeting the discharge standards. The sewage of another 30 ships was discharged without any treatment and its pollutants failed to meet discharge standard.

Based on investigation findings and monitoring results as well as the amount of various ships, annual generation amount of ship sewage, passenger amount, crew number, ship annual operation time, and the percentage of different tonnage ships, it was estimated that the amount of domestic sewage from ships in the Three Gorges Reservoir waters in 2009 was 3.997 million t, down by 1.2% compared with that of 2008. Among them, the amount of sewage from passenger and tourist ships was 3.106 million t (2.588 million t for passenger ships and 518,000 t for tourist ships), accounting for 77.7% of the total; the sewage amount from non-passenger ships was 891,000 t, accounting for 22.3%.

In the discharged sewage, the total weight of various pollutants was 2116.2 t, down by 0.9% compared with that of last year. The amount of discharged pollutants were 716.6 t of COD, 710.6 t of suspended substances, 338.5 t of TN, 299.4 t BOD_5, and 51.1 t TP, accounting for 33.9%, 33.6%, 16.0%, 14.1% and 2.4% of the total respectively.

3.4.4 Ship garbage

In 2009, inspectors boarded 60 ships to investigate garbage generation and treatment. Based on such factors such as the tonnage, crew number, passenger amount, annual navigation time, annual garbage amount and the percentage of the amount of subject ship to total ship amount of the reservoir waters, it was estimated that total garbage from the ships in reservoir waters was 30,000 t, up by 3.4% compared with that of last year.

3.4.5 Ship accidents

There were 5 ship traffic accidents in the Three Gorges Project area in 2009. Two of them were general traffic accidents and 3 small accidents. Five ships sunk in these accidents. Among them, 3 ship accidents were due to artificial factors, including poor operation and navigation against regulations under overload or over height conditions.

Chapter 4
Status of Water Environment Quality

In 2009, monitoring of the quality of water environment of the Three Gorges Project area included the monitoring on water quality of both mainstream and tributaries of the Yangtze River and water bloom of primary tributaries. The assessment of water quality complies with Environmental Quality Standard for Surface Water (GB3838-2002). The assessment of comprehensive nutrition status of water bodies complies with the *Technical Regulations on Eutrophication Evaluation Method and Grading for Lakes (Reservoirs)* developed by China National Environmental Monitoring Center.

4.1 Water quality monitoring

In 2009, 7 water quality monitoring sections were established at mainstream of the Yangtze River in the reservoir areas. They were located at Tongguanyi and Cuntan of Chongqing Municipality; Qingxichang in Fuling; Tuokou in Wanzhou; Shaiwangba, Peishi in Wushan and Guandukou in Badong County. In primary tributaries of the Yangtze River, Beibei section, Linjiangmen section, and Daxikou section of Jialing River water quality monitoring sections were established; two water quality monitoring sections were set up in Wulong and Maliuzui of Wujiang River. A total of 82 monitoring sections were established in 38 main tributaries of the Yangtze River subject to the influence of the mainstream of the Yangtze River and Kuwan waters with similar hydrological conditions.

4.1.1 Water Quality of the mainstream

In 2009, among the 7 sections at the mainstream of the Three Gorges Project area, Cuntan, Qingxichang, Shaiwangba and Peishi met Grade II national surface water quality standard; while Tongguanyi section, Tuokou section and Guandukou section met Grade III national.

Among the 7 sections, 85.7% met national Grade I~III water quality standard during June-August, 100% sections met Grade I~III standard during other months. The water quality of Tongguanyi section only met Grade IV standard during June and July with main pollutants being petroleum and permanganate value. The water quality of Tuokou in August met Grade V standard with key pollutant being lead. In other months, the water quality of all sections met or was superior to Grade III standard.

Table 4–1 Water quality of the mainstream of the Yangtze River in the Three Gorges Project area in 2009

Section name	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Tongguanyi	III	II	II	II	II	IV	IV	III	III	II	II	III	III
Cuntan	II	II	II	II	II	II	II	II	II	II	II	II	II
Qingxichang	III	III	II	III	II	II	II	III	II	II	I	I	II
Tuokou	I	III	III	III	III	III	III	V	III	III	III	I	III
Shaiwangba	I	II	II	II	II	II	III	III	II	II	II	II	II
Peishi	II	I	II	I	II	II	II	III	II	I	II	II	II
Guandukou	I	I	I	I	I	II	III	III	III	III	II	II	III

Note: The concentration of TP is not involved in assessment of water quality due to relatively big influence of the mud concentration in water.

Table 4–2 Percentage of graded water quality at mainstream sections of the Yangtze River of Three Gorges Reservoir area in 2009 (%)

Water quality	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Whole year
Ⅰ	42.9	28.6	14.3	28.6	14.3	0.0	0.0	0.0	0.0	14.2	14.3	28.6	0.0
Ⅱ	28.6	42.9	71.4	42.9	71.4	71.4	42.9	14.3	57.1	57.1	71.4	57.1	57.1
Ⅲ	28.6	28.6	14.3	28.6	14.3	14.3	42.9	71.4	42.9	28.6	14.3	14.3	42.9
Ⅳ	0.0	0.0	0.0	0.0	0.0	14.3	14.3	0.0	0.0	0.0	0.0	0.0	0.0
Ⅴ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0
>Ⅴ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ⅰ～Ⅲ	100.0	100.0	100.0	100.0	100.0	85.7	85.7	85.7	100.0	100.0	100.0	100.0	100.0

4.1.2 Water quality of the Jialing River and Wujiang River

The water quality of Beibei section, Linjiangmen section and Daxigou section of the Jialing River met Grade II standard in 2009. The water quality of Maliuzui section and Wulong section in Wujiang River met Grade II and I respectively.

Among the 5 monitoring sections of the Jialing River and Wujiang River, 80.0% of them met Grade I~III water quality standard in January, February and August and 100.0% met Grade I~III quality standard in other months. The water quality of Beibei met Grade IV standard in February; the water quality of Linjiangmen section only met Grade IV standard in January and August with petroleum as the main pollutant.

Table 4–3 Type of water quality of the sections of Jialing River and Wujiang River in 2009

Section name	River name	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Whole year
Beibei	Jialing River	Ⅱ	Ⅳ	Ⅲ	Ⅱ	Ⅱ	Ⅱ	Ⅲ	Ⅲ	Ⅱ	Ⅱ	Ⅱ	Ⅰ	Ⅱ
Linjiangmen	Jialing River	Ⅳ	Ⅲ	Ⅲ	Ⅱ	Ⅱ	Ⅱ	Ⅱ	Ⅳ	Ⅲ	Ⅱ	Ⅰ	Ⅱ	Ⅱ
Daxigou	Jialing River	Ⅱ	Ⅱ	Ⅱ	Ⅲ	Ⅱ	Ⅱ	Ⅱ	Ⅱ	Ⅱ	Ⅲ	Ⅱ	Ⅱ	Ⅱ
Maliuzaui	Wujiang river	Ⅲ	Ⅲ	Ⅱ	Ⅰ	Ⅱ	Ⅱ	Ⅱ	Ⅱ	Ⅱ	Ⅰ	Ⅱ	Ⅰ	Ⅱ
Wulong	Wujiang river	Ⅲ	Ⅲ	Ⅲ	Ⅰ	Ⅰ	Ⅰ	Ⅱ	Ⅰ	Ⅰ	Ⅱ	Ⅰ	Ⅰ	Ⅰ

Table 4–4 Percent of graded water quality of the sections of Jialing River and Wujiang River in 2009 (%)

Water quality	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Whole year
I	0.0	0.0	0.0	40.0	20.0	20.0	0.0	20.0	20.0	20.0	40.0	60.0	20.0
II	40.0	20.0	40.0	40.0	80.0	80.0	80.0	40.0	60.0	60.0	60.0	40.0	80.0
III	40.0	60.0	60.0	20.0	0.0	0.0	20.0	20.0	20.0	20.0	0.0	0.0	0.0
IV	20.0	20.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0
V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
>V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I ~III	80.0	80.0	100.0	100.0	100.0	100.0	100.0	80.0	100.0	100.0	100.0	100.0	100.0

4.1.3 Water quality of main tributaries

76.8~96.4% of river sections of main tributaries of the Yangtze River in the Three Gorges Reservoir area met Grade I~III water quality standard, 0.0~12.2% met Grade IV standard, 0.0~4.9% met Grade V standard and 0.0~7.3% failed to meet Grade V standard during March~October of 2009 with major pollutants being permanganate value, ammonia nitrogen and BOD_5. In general, the water quality of the main tributaries of the Yangtze River in the Three Gorges Project areas was the poorest in July.

The percent of river sections of major tributaries in the Three Gorges Project area meeting Grade I~III water quality standard had some reduction during June, July and September and some increase during March~May, August and October compared with the same period of last year. On the average, 91.2% of the river sections met Grade I~III water quality standard during March~October, up by 2.5 percentage points compared with that of last year.

Table 4–5 Percent of graded water quality at sections of primary tributaries of the Yangtze River of Three Gorges Reservoir area during March~October of 2009

Water quality	March	April	May	June	July	August	September	October	Monthly average
I	36.6	23.2	18.3	9.8	1.2	3.7	2.4	8.5	13.0
II	40.2	47.6	43.9	52.4	43.9	50.0	63.5	72.0	51.7
III	19.6	25.6	25.6	24.4	31.7	40.2	30.5	14.6	26.5
IV	1.2	0.0	8.5	6.1	12.2	3.7	1.2	3.7	4.6
V	2.4	2.4	0.0	0.0	4.9	1.2	2.4	0.0	1.6
>V	0.0	1.2	3.7	7.3	6.1	1.2	0.0	1.2	2.6
I ~III	96.4	96.4	87.8	86.6	76.8	93.9	96.4	95.1	91.2

4.2 Water Bloom and Nutrition Status of Primary Tributaries

4.2.1 Early warning monitoring for water bloom

Five indicators such as chlorophyll a, TP, TN, permanganate value and turbidity were employed to assess comprehensive nutrition status of water bodies.

The findings showed that 10.9~42.7% of the sections of primary tributaries were subject to eutrophication between March and October of 2009 with monthly average being 26.9%, up by 6.8 percentage points

compared with that of 2008. 0.0~4.9% of the river sections were under oligotrophic condition and 57.3~89.1% under mesotrophic condition with monthly average at 2.3% and 70.8% respectively. Due to the impact of impoundment, backwater reaches of the reservoir area showed evidently higher level of eutrophication than non-backwater reaches. 12.5~60.42% of sections of backwater reaches were eutrophic with monthly average of 35.16%, 22.1 percentage points higher than that in non-backwater reaches.

Table 4–6 Nutrition status of primary tributary waters of the Yangtze River in the Three Gorges Reservoir area during March~October of 2009

Nutrition status	Percent of sections under different nutrition conditions (%)								
	March	April	May	June	July	August	Sep.	October	Average
Oligotrophic	3.7	0.0	4.9	0.0	0.0	2.4	2.4	4.9	2.3
Mesotrophic	80.5	89.1	59.3	57.3	68.3	68.3	63.4	80.5	70.8
Slight eutrophication	15.8	7.3	25.9	34.2	28.0	25.6	30.6	14.6	22.8
Intermediate eutrophication	0.0	1.2	7.4	6.1	3.7	3.7	1.2	0.0	2.9
Heavy eutrophication	0.0	2.4	2.5	2.4	0.0	0.0	2.4	0.0	1.2
Total of eutrophication	15.8	10.9	35.8	42.7	31.7	29.3	34.2	14.6	26.9

4.2.2 Site monitoring of water bloom

Water bloom occurred in such streams and rivers as Longhe River, Xiangdu River, Zhuxi River , Xiaojiang River, Modao River, Tangxi River, Daxi River, Zhuyi River, Meixi River, Caotang River, Shennü River, Baolong River, Daning River, Sanxi River, Shennong Stream, Qinggan River, and Xiangxi River in the Three Gorges Reservoir area in 2009. The dominant algae species were mainly *Cyclotella* of *Bacillariophyta*, *Peridinaceae* of *Pyrrophyta; Chlamydomonas* and *Pandorina* of *Chlorophyta; Cryptomonas* of *Cryptophyta*; and *Aphanizomenon flos-aquae* and *Microcystis of Cyanophyta*.

Chapter 5
Environment Quality in Construction Areas

5.1 Hydrology and Meteorology

5.1.1 Hydrological characteristics

In 2009, the statistic analysis on the monitoring data at Huanglingmiao Hydrological Station downstream the key water control project of the Three Gorges showed that the annual average flow was 12100 m^3/s with maximum flow of 40400 m^3/s on August 5 and minimum at 4760 m^3/s on December 30. Annual average sand transportation rate was 1.14 t/s, with average sand concentration of 0.094 kg/m^3. The maximum average sand concentration at sections was 0.824 kg/m^3 on August 9, the minimum average, the average sand concentration was 0.001 kg/m^3 on January 14. The construction area of the Three Gorges Project featured slight drop of annual average flow and some rise of annual average of sand transportation rate and average sand concentration compared with that of last year.

Table 5–1 Monthly river flow of Huanglingmiao Hydrological Stations in 2009

Unit: m^3/s

Time	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Whole year
Average	5150	5970	5610	7910	14700	14100	23600	30500	17000	8250	6580	5150	12100
Maximum	5600	8640	6640	14700	19100	28700	33000	40400	28000	10800	9570	5670	40400
Minimum	4810	4880	5070	5200	10200	9890	16100	22000	10700	6680	5320	4760	4760

Table 5–2 Sand concentration of Huanglingmiao Hydrological Stations in each month of 2009

Unit：kg/m^3

Time	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Whole year
Average	0.002	0.003	0.004	0.004	0.008	0.010	0.111	0.311	0.053	0.008	0.004	0.003	0.094
Maximum	0.004	0.003	0.004	0.005	0.012	0.029	0.238	0.824	0.151	0.023	0.005	0.004	0.824
Minimum	0.001	0.002	0.003	0.003	0.004	0.006	0.026	0.134	0.013	0.004	0.003	0.002	0.001

5.1.2 Climate Characteristics

In 2009, the climate characteristics of the Three Gorges Project area were mild with less rain. In general, the air temperature was normal with less precipitation compared with the historical average.

● Precipitation

The annual precipitation of the construction area was 945.5mm, 21.2% less than the historical average. The distribution of precipitation in each month was especially uneven, for most precipitation was seen during April~September with maximum daily precipitation of 59.5 mm occurred on September 20. The longest period of continuous rain throughout the year lasted 13 days occurred in January. The longest non-precipitation period in the year was 7 days occurred in May.

● Air temperature

The temperature of the construction area averaged 17.1℃, 0.2℃ lower than the historical average. The

annual extremely high temperature in 2009 was 38.8℃ on July 18, while the annual extremely low temperature was -1.9℃ on January 13.

● **Wind speed**

The annual average wind speed of the construction area was 1.1 m/s with the maximum of 21.9 m/s on August 15. Wind direction was changeable during the year with N in dominance at the frequency of 13%.

Table 5–3 Meteorological indicators of the Three Gorges Project area in 2009

Month		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Whole year
T	Temperature (℃)	5.5	9.6	12.2	17.1	20.6	26.5	27.6	26.3	23.1	19.0	10.1	7.3	17.1
	Departure(℃)	-0.1	1.7	-0.6	-0.6	-1.4	1.0	0.2	-0.1	-0.1	0.9	-3.0	-0.1	-0.2
P	Precipitation(mm)	11.6	43.4	36.6	132.1	138.8	160.7	99.8	112.6	124.7	35.6	29.2	20.4	945.5
	Departure (%)	-55.4	-25.1	-32.9	6.8	7.8	11.3	-45.7	-48.7	23.3	-60.2	-41.5	0.9	-21.2
W	Average wind speed(m/s)	1.4	1.3	1.3	1.0	0.9	1.0	1.0	1.1	0.9	0.7	1.5	1.4	1.1
	Maximum(m/s)	7.0	5.2	6.1	11.7	5.7	8.3	6.3	12.6	7.0	5.9	5.4	6.0	12.6
	Extreme(m/s)	12.4	10.0	9.6	12.1	10.4	12.5	10.4	21.9	11.5	13.6	9.7	9.4	21.9

5.2 Air Quality

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

In 2009, the annual average SO_2 concentration in the construction area was 0.011 mg/m^3, meeting Grade I national air quality standard, down by 0.006 mg/m^3 compared with that of 2008. Daily average concentration has all met Grade I or Grade II national air quality standard which made up 98.6% and 1.4% of the total respectively.

Annual NO_2 concentration was 0.024 mg/m^3, meeting Grade I national air quality standard, down by 0.001 mg/m^3, compared with that of last year. All the daily average NO_2 concentrations met Grade I standard. The annual average of TSP was 0.142 mg/m^3, meeting Grade II national air quality standard. Among them, the daily average concentrations of TSP in office and residential areas meeting Grade I and II air quality standard was 37.5% and 62.5% respectively; the daily average concentrations of TSP in construction area meeting Grade I and II air quality standard was 33.3% and 66.7% respectively.

The overall ambient air quality of the construction area became better, there was a 35.3% reduction of annual average of SO_2 concentration, 4.0% reduction of annual average of NO_2 and 7.8% reduction of annual average of TSP compared with that of last year. There was no daily average concentration of air pollutants failing to meet Grade II air quality standard.

5.3 Water quality

A total of 13 indicators such as pH, dissolved oxygen, ammonia nitrogen, COD, permanganate value, BOD_5, volatile phenol, cyanide, arsenic, Cr^{6+}, copper, lead, and cadmium were chosen for the assessment of water quality in construction area according to *Environmental Quality Standard for Surface Water* (GB3838-2002) (GB3838-2002). Anion surfactant indicator was added to evaluate near-bank water quality.

In 2009, water quality at sections of the construction area at the mainstream and near-bank waters of the Yangtze River was good, meeting Grade I~II surface

water quality standard throughout the year. Compared with that of 2007, the annual water quality at Taipingxi section and Letianxi section of the mainstream of the Yangtze River degraded from Grade I to Grade II with slight rise of annual average of suspended substance and E-coli. The water quality of near-bank waters kept at Grade I. Among them, there was no obvious change of water pollutant concentration of the monitoring sites at upper approach channel, lower approach channel and auxiliary dam.

Table 5–4 Water quality of the mainstream sections of the Yangtze River in the construction area in 2009

Section name	The first quarter	The second quarter	The third quarter	The fourth quarter	Whole year
Taipingxi	I	II	II	II	II
Letianxi	I	II	II	II	II

Table 5–5 Water quality of near–bank waters of the Yangtze River in the construction area in 2009

Sampling site		The first quarter	The second quarter	The third quarter	The fourth quarter	Whole year
Left bank (30m to the bank)	Upper approach channel	II	I	II	II	I
	Lower approach channel	I	I	II	II	I
Right bank (30m to the bank)	Auxiliary dam	I	II	II	II	I

5.4 Noise

The average daytime and night noise of the office and residential area of the construction areas was 56.3 dB and 48.3 dB in 2009, both meeting Grade II limit of *Environmental Noise Standard of Urban Area* (GB3096-2008), up by 0.2 dB and down by 2.7 dB respectively compared with that of last year. The average of environmental noise in construction operation area was 50.7 dB during daytime and 44.9 dB in night, both meeting the limits for workshops and operation sites specified in national *Specifications for the Design of Noise Control System in Industrial Enterprises* (GBJ87-85), down by 3.1 dB and 3.6 dB respectively. The noise level of sensitive boundary sites complied with the *Noise Limits for Construction Site* (GB12523-90). The annual average of traffic noise of the construction area of the Three Gorges Project was 62.5 dB, down by 5.7 dB compared with that of last year.

Chapter 6
Status of Public Health

6.1 Basic Situation

In 2009, the Three Gorges Reservoir area had the same distribution of monitoring sites for public health as in the last year, including Chongqing City; Fengdu County, Wanzhou District and Fengjie County of Chongqing Municipality; and 17 towns, townships and urban communities in Yichang City of Hubei Province. Total population under monitoring this year was 629857, up by 34449 people compared with that of last year. Among them, 322628 were male and 307229 female with gender ratio of 1.05:1; 233535 people were urban residents and 396322 rural residents.

There were 334 medical institutions at all levels within the monitoring regions, up by 5 compared with that of last year. There were a total of 3550 hospital beds in all these institutions, up by 125 compared with that of last year. Altogether 4118 medical staff worked in these institutions, down by 435 people compared with that of last year mainly due to adjustment of medical institutions in the Three Gorges Reservoir area.

6.2 Life Statistics

6.2.1 Birth and death

A total of 4464 babies were born in the monitoring sites in Chongqing, Fengdu, Wanzhou, Fengjie and Yichang in 2009, 2400 of them were male and 2064 female with gender ratio at 1.16:1; the birth rate was 7.09‰, up by 2.01% compared with that of 2008. A total of 3710 people died with mortality of 5.89‰, up by 2.26% compared with that of last year; 2219 of them were male and 1491 female with death rate of 6.88‰ and 4.85‰ respectively.

The birth rate of the monitoring sites in Chongqing, Fengdu, Wanzhou, Fengjie and Yichang was 5.41‰, 9.76‰, 5.62‰, 12.51‰ and 6.70‰ respectively with death rate of 4.96‰, 7.07‰, 5.38‰, 5.07‰ and 7.38‰. The birth rate went down by 13.72% in Chongqing, 6.24% in Fengdu, 2.19% in Yichang and 0.35% in Wanzhou. The death rate of Yichang, Fengdu and Wanzhou had some rise compared with that of last year; rising by 16.40%, 4.59% and 1.51% respectively; while the death rate in Chongqing went down by 6.77%.

A total of 41 baby deaths were reported in all monitoring areas including 24 male and 17 female; the infant death rate was 9.18‰, up by 8.51% compared with that of last year.

6.2.2 Analysis of death cause

According to the ICD-10 Disease Classification Standard, the top five death causes of the people in the Three Gorges Reservoir areas in 2009 circulatory system diseases, malignant tumors, respiratory system diseases, injury & poisoning and digestive system diseases with death rate at 207.03/100,000, 160.99/100,000, 80.49/100,000, 61.44/100,000 and 20.48/100,000 respectively. The percent of death resulting from the above five major diseases against the total death was 35.15%, 27.33%, 13.67%, 10.43% and 3.48% respectively, totaling 90.06%.

Compared with 2008, the order of the top five killer diseases remained unchanged and there was little change in death cause structure. Among them, death rate caused by circulatory system diseases went down by 0.83%; while the death rate caused by injury & poisoning, digestive system diseases, malignant tumors and respiratory system diseases went up by 10.19%, 9.87%, 9.30% and 2.84% respectively. Gender analysis showed that the rank of the top five death causes for both male and female was the same as that of the general population with higher mortality of male than female. Regional analysis showed that the rank of death causes varied. The top three killer diseases in Chongqing, Fengdu, Wanzhou and Fengjie was the same as that of the general population, while in Yichang the No.1 death

causes was the same as that of general population and injury & poisoning came the second and tumors the third.

6.3 Monitoring of Diseases

6.3.1 Monitoring of infectious diseases

In 2009, a total of 4113 cases of infectious diseases were reported among all the monitoring sites with a morbidity of 653.01/100,000, down by 1.62% compared with that of last year. There was no report of death due to infectious diseases, and no report of any case of Category A infectious diseases. The morbidity from high to low was 882.18/100,000 in Fengdu, 811.73/100,000 in Chongqing, 596.12/100,000 in Yichang, 525.52/100,000 in Wanzhou and 371.97/100,000 in Fengjie. The morbidity of Wanzhou, Chongqing and Yichang went up by 25.60%, 10.02% and 7.22% respectively, while the morbidity of Fengjie and Fengdu went down by 48.99% and 21.43% compared with that of last year. There were reports of infectious diseases in each monitoring sites in each month but report on outbreak of endemic diseases. There was no big fluctuation of report cases of Category B infectious diseases during January~November with relatively small amount in December. The amount of Category C infectious diseases was relatively high in April, June, September and November, which were mainly foot & mouth disease, parotitis, flu and other types of infectious diarrhoea.

The monitoring sites reported of 2124 cases of 12 types of Category B infectious diseases (excluding HIV) with morbidity of 337.22/100,000, down by 23.56% compared with that of last year. The morbidity of Category B infectious diseases was highest at 446.89/100,000 in Fengdu and lowest at 210.91/100,000 in Wanzhou. The morbidity in Yichang increased by 3.53%, while the morbidity in Fengjie, Fengdu, Chongqing and Wanzhou went down by 54.27%, 35.65%, 23.34% and 22.78% respectively compared with that of last year. The top five diseases in terms of morbidity were tuberculosis (140.51/100,000), virus hepatitis (120.82/100,000), dysentery (26.20/100,000), syphilis (19.69/100,000) and gonorrhea (12.54/100,000). In 2009, Type A H1N1 flu and malaria were added in Category B infectious diseases, while whooping cough, epidemic cerebrospinal meningitis, hemorrhagic fever, leptosprirosis, encephalitis B were removed compared with that of last year. The morbidity of type C hepatitis, Type E hepatitis, typhoid and syphilis had some increase compared with that of last year; while that of other disease had some reduction; among them, there was a 89.66% reduction of measles morbidity and 183% rise of HIV victims compared with that of last year. The morbidity of hepatitis A (4.29/100,000), dysentery (26.20/100,000) and typhoid (0.95/100,000) having something to do with the impoundment was still at low level. There was one case of malaria which has something to do with the change of biological media. But there was no case of leptosprirosis, type B meningitis and epidemic hemorrhagic fever.

A total of 1989 disease cases of 6 kinds of Category C infectious diseases were reported in all monitoring sites with morbidity at 315.79/100,000, up by 41.90% compared with that of last year. The morbidity of Fengdu, Chongqing, Wanzhou, Yichang and Fengjie was 435.29/100,000, 421.12/100,000, 314.62/100,000, 164.41/100,000 and 41.11/100,000 respectively. The occurrence of Category C infectious diseases in all monitoring sites went up compared with that of last year. Among them, the morbidity of such diseases in Fengjie and Wanzhou went up by 6.21 times and 1.17 times.

6.3.2 Monitoring of endemic diseases

Iodine deficiency was monitored in monitoring sites in Chongqing, Wanzhou, Fengdu, Yichang and Fengjie in 2009. Palpation method was employed to investigate the iodine deficiency among 899 sampled children aged 8~12. Among them, 62 were found to have Io thyromegaly, accounting for 6.90% with slight decrease compared with that of 2008, the disease was still in the range of slight epidemic. Thyromegaly rate in Fengdu and Wanzhou was 7.90% and 7.14% respectively with no case in Chongqing. Thyromegaly rate in Fengdu, Chongqing and Wanzhou dropped by 25.68%, 100.00% and 52.40% respectively compared with that of last year. 2158 households were sampled for the test of edible salt, 2146 of them took iodine added salt, taking up 99.44%, up by 0.82 percentage point. The iodine added salt in 2099 households was qualified, taking up 97.81%, up by 2.97 percentage points. The consumption rate of qualified iodine-added salt was 97.27%, up by 3.74 percentage points. The iodine added salt coverage,

qualification rate of iodine-added salt and consumption rate of qualified iodine-added salt went up to some degrees. In particular, the obvious increase of the above three indicators at monitoring site in Fengdu was mainly due to relevant measures including enhanced supervision on the salt without addition of iodine.

Fluorine endemic disease was monitored in Fengjie with investigation of 1281 people. 397 cases of such disease were found with positive rate at 30.99%, down by 34.26% compared with that of 2008.

6.4 Monitoring of Biological Media

6.4.1 Monitoring of rats

In 2009, indoor rat density of all the monitoring sites was 2.06%, slightly lower than that of 2008, while outdoor rat density was 3.09%, slightly higher than that of 2008, but both were lower than the 5-year (1999-2003) average indoor and outdoor rat density (3.94% and 4.22%) before 135 m impoundment. The density in spring was higher than that in autumn. In the spring, indoor rat density (2.79%) was lower than outdoor density (3.12%), in the autumn, the indoor rat density (1.24%) was lower than outdoor density (3.07%), which was different from the last year. The in-door mouse density from high to low was 4.74% in Fengdu, 2.54% in Wanzhou, 2.20% in Yichang, 1.62% in Fengjie, 0.48% in Chongqing. The outdoor mouse density from high to low was 9.47% in Fengdu, 4.48% in Wanzhou, 4.02% in Chongqing, 1.87% in Yichang and 0.71% in Fengjie.

Rattus flavipectus was dominant indoor rat species, taking up 47.27%, followed by *Rattus norvegicus*, taking up 22.73%. Rattus flavipectus has been the indoor dominant rat species in the past two consecutive years with rise in its proportion, this was mainly due to increased catch in Yichang in the past two years. In the field, the small insectivore (mostly short-tail shrew) was the dominating species, accounting for 59.41%, up by 4.91 percentage points. Black strip rat (*Apodemusagrarius*) accounted for 8.86% ranking the third, down by 9.64 percentage points compared with that of 2008. As the animal host of epidemic hemorrhagic fever and leptospiral pathogens, *Apodemusagrarius* has ranked No.2 or No.3 over the past few years.

6.4.2 Monitoring of mosquitoes

In 2009, the overall density of adult mosquitoes in livestock pens and human dwellings was respectively 126.09 pen • artificial hour and 26.88 room • artificial hour respectively, both were lower than the level of 2008 and the 5-year averages (198.57/ pen • artificial hour for the former and 63.97/ room • artificial hour for the latter) before 135 m impoundment. Indoor adult mosquito density at all monitoring sites was sequenced from high to low from high to low was Yichang (135.76/ room • artificial hour), Wanzhou (44.48/room • artificial hour), Chongqing (39.59/ room • artificial hour), Fengdu (19.16/ room • artificial hour), Fengjie (15.84/ room • artificial hour). The adult mosquito density in livestock pens from high to low was Wanzhou (209.84/pen • artificial hour), Yichang (135.76/pen • artificial hour, Fengdu (117.76/pen • artificial hour), Chongqing (108.29/ pen • artificial hour) and Fengjie (61.44/pen • artificial hour). The mosquito density in livestock pens rose in Chongqing but went down in Yichang, Wanzhou and Fengdu compared with that of 2008, while the indoor adult mosquito density had some rise in Chongqing and Yichang but some reduction in Fengdu and Wanzhou.

10-day change trend of indoor adult mosquito density during May-September was similar to that of the adult mosquito density in livestock pens. Chongqing was the first to see the peak of indoor adult mosquito density in early May, while Wanzhou was the last where the density was the highest in early July, the peak of indoor adult mosquito density occurred early June in Fengdu and late June in Yichang and Fengjie. For adult mosquito density in livestock pens, the peak came first in Chongqing and Wanzhou in early June. Other monitoring sites witnessed the peak in late June.

The composition of mosquito species showed that *Armigeres subbalbeatus* was the dominating mosquito species in both human dwellings and livestock pens, accounting for 76.30% and 79.08%. *Culex pipiens fatigans* ranked No.2 as indoor mosquito species, taking up 10.99%. *Culex pipiens pallens, Culex tritaeniorhynchus* and *Anopheles sinensis* ranked the third, fourth and fifth respectively. Among the livestock pen mosquito species, *Anopheles sinensis* ranked No.2 and took up 9.40%; *Culex pipiens fatigans, Culex pipiens pallens, Culex tritaeniorhynchus* ranked the

third, fourth and fifth. The percent of other mosquito species in human dwellings went up compared with that of 2009 except Anopheles sinensis. For livestock pens, the percent of *Culex pipiens pallens and Culex tritaeniorhynchus* went down, while the percent of other mosquito species went up.

Chapter 7
Environmental Quality of Resettlement Areas

In 2009, comprehensive environmental monitoring was carried out in 15 districts (counties) within Chongqing resettlement area of the Three Gorges Reservoir area including Wushan County, Wuxi County, Fengjie County, Yunyang County, Wanzhou District, Kaixian County, Zhong County, Shizhu County, Fengdu County, Wulong County, Fuling District, Changshou District, Banan District, Yubei District and Jiangjin District. Monitoring focused on quality of water environment, ambient air and acoustic environment.

7.1 Water Quality

Water quality monitoring in the resettlement area targeted surface water quality, water quality of sensitive backwater zones and water quality in drinking water source areas. The assessment of water quality complies with *Environmental Quality Standard for Surface Water* (GB3838-2002),The assessment of comprehensive nutrition status of waters complies with the *Technical Regulations on Eutrophication Evaluation Method and Grading for Lakes (Reservoirs)* developed by China National Environmental Monitoring Center.

7.1.1 Surface water quality

146 sections were set up along 55 rivers in 15 districts (counties), up by 18 compared with that of last year. Assessment of water quality included 20 items such as pH, dissolved oxygen, permanganate value, COD, BOD_5, ammonia nitrogen, copper, zinc, fluoride, selenium, arsenic, cadmium, mercury, hexavalent chromium, lead, cyanide, volatile phenol, petroleum, anion surfactant and sulfide.

In 2009, the quality of surface water of the resettlement areas kept stable. The overall status was good with 132 sections meeting or superior to Grade III national water quality standard, accounting for 90.4%, up by 2.1 percentage points compared with that of last year. There were 5 Grade IV sections, 2 Grade V sections and 7 sections failing to meet Grade V water quality standard 2, accounting for 3.4%, 1.4% and 4.8% of the total with COD and ammonia nitrogen as major pollutants.

The proportion of sections meeting or superior to Grade III quality standard in low, level and high flow periods was 89.7%, 84.9% and 90.4% respectively, up by 2.1, 1.5, 2.8 percentage points compared with that of last year. River sections failing to meet Grade III standard were mainly in Banan District and Wanzhou District, while the percent of sections meeting or superior to Grade III went up by 2.1 percentage points compared with that of 2008.

7.1.2 Water quality of sensitive Backwater zones

64 sections were set up along 38 tributaries running across 12 districts (counties), up by 7 compared with that of last year. The 11 monitoring items included water turbidity, water temperature, pH, dissolved oxygen, permanganate value, BOD_5, TN, ammonia nitrogen, nitrate, chlorophyll-a and total phosphorus.

● **Water quality**

Six indicators including pH, dissolved oxygen, permanganate value, BOD_5, TN, ammonia nitrogen and TP were employed to assess water quality.

In 2009, the overall water quality in sensitive backwater areas of the resettlement region was good with 56 sections meeting or superior to Grade III national water quality standard, accounting for 87.5% of the total; there were 2 Grade IV sections, 2 Grade V sections and 4 sections failing to meeting Grade V standard, taking up 3.1%, 3.1% and 6.3% of the total. The main pollutants were BOD_5, TP and ammonia nitrogen.

The proportion of monitoring sections in backwater sensitive zones meeting or superior to Grade III water quality standard during March, April and May was 93.5%, 84.4% and 81.2% respectively, up by 0.6 percentage point in March, down by 10.4 percentage points in April and 4.8 percentage points in May

compared with that of last year. Local rivers with relatively poor water quality included Zhuxi River in Wanzhou, Wujiang River in Fuling District and Huaxi River & Yipin River in Banan District.

The percent of sections in backwater sensitive zones meeting or superior to Grade III standard went down by 7.2 percentage points in 2009 compared with that of last year.

● **Nutrition of water bodies**

Five indicators including chlorophyll-a, TP, TN, turbidity and permanganate value were employed to evaluate nutrition status of the water bodies.

The trophic state index of backwater sensitive zones ranged from 21.03 to 63.29 in 2009. 15 river sections were under eutrophication, accounting for 23.5% of the total. Among them, 12 sections were under slight eutrophication and 3 sections under intermediate eutrophication, taking up 18.8% and 4.7% respectively. Two sections were under oligotrophic condition and 47 sections were under mesotrophic conditions, taking up 3.1% and 73.4% respectively.

7.1.3 Water quality of drinking water sources

A total of 118 monitoring sites were established at 97 major centralized drinking water sources of 15 districts (county cities) and Class I towns, the same as in 2009, same as in 2008. Water quality assessment covered 22 items (excluding TN and fecal coliforms) as provided in *Environmental Quality Standard for Surface Water* (GB3838-2002) sulfate, chloride and nitrate (calculated by nitrogen).

In 2009, water quality of centralized drinking water sources in county cities and Class I towns of the resettlement region was good, 97.0% of the source areas met water quality requirement, down by 2.0 percentage points.

7.2 Air Quality

In 2009, monitoring work of environmental air quality of the resettlement area mainly included the monitoring of urban air quality and precipitation quality.

7.2.1 Ambient air quality

A total of 25 ambient air quality monitoring sites were established in the 15 districts (counties) with 31 dust monitoring sites. Monitoring work targeted SO_2, NO_2, inhalable particles and dust. The *Ambient Air Quality Standard* (GB3095-1996) was applied in the assessment of the environmental air quality.

In 2009, urban air quality of the resettlement area had slight degradation with 6.7% rise of comprehensive air pollution index compared with that of 2008.

The annual average SO_2 concentration was 0.034 mg/m^3, meeting Grade II national air quality standard. The daily average SO_2 concentration was 0.001~0.479 mg/m^3 with 0.6% of the total failing to meet national air quality standard. The highest daily average was 2.19 times of the limit. Among the 15 districts (counties) under statistics, the annual average SO_2 concentration of 14 of them met Grade II national air quality standard, accounting for 93.3%.

The annual average NO_2 concentration was 0.028 mg/m^3 and met Grade II national air quality standard. The daily average NO_2 concentration was 0.001~0.153 mg/m^3, 0.3% of them went beyond the emission limit. All the annual average NO_2 concentrations of the 15 districts (counties) met Grade II national air quality standard.

The annual average concentration of inhalable particulates was 0.091 mg/m^3 and met Grade II national air quality standard. The daily average ranged from 0.006 to 0.414 mg/m^3, 9.9% of them went beyond the emission limit with the maximum daily average 1.76 times higher than the emission limit. Among the 15 districts or counties, the annual average particulate level of 12 met Grade II standard, taking up 80.0%.

The annual average amount of dust fall was 5.74 t/km^2 • month, 0.50 times higher than the reference limit. The maximum monthly average exceeded the limit by 1.74 times. Among the 15 districts or counties, the annual average level of dust fall amount of 5 districts or counties was lower than the reference standard, accounting for 33.3%, down by 33.3 percentage points compared with that of last year.

7.2.2 Precipitation quality

In 2009, 18 precipitation monitoring sites were

established in 14 districts (counties) (none in Wuxi) with 584 rain samples collected, 320 of them were acid rain samples. The acid rain frequency was 54.8% and the amount of acid rain took up 57.2% of the total, down by 0.9 and 5.1 percentage points respectively compared with that of last year. The monitored pH value of the precipitation ranged from 3.19 to 8.29 with average of 4.73. Among the 14 districts or counties under statistics, the annual average pH of the precipitation of 12 districts or counties was less than 5.60, taking up 85.7%, up by 12.4 percentage points compared with that of 2008.

7.3 Noise

In 2009, the monitoring of acoustic environmental quality in the resettlement areas included monitoring of regional environmental noise, traffic noise and functional area noise. The assessment work complied with the *Standard of Acoustic Environment Quality* (GB3096-2008).

7.3.1 Regional environmental noise

A total of 1429 monitoring grids of regional environmental noise were established in cities and towns of the 15 districts (counties), covering 178.42 km^2 in urban built areas, 2~4 monitoring were conducted in 2009.

In 2009, the overall regional acoustic environment of the resettlement area was good with the equivalent sound level at 53.8 dB. Among them, Wuxi County had the highest equivalent sound level at 57.1 dB; Changshou District posted the lowest level at 51.8 dB. The noise source was dominated by domestic noises, taking up 66.1%; followed by traffic noise that took up 19.8%. Among the 1429 noise monitoring grids, 1367 met national noise standard, accounting for 95.7%. The percent of monitoring grids meeting Class I, II, III and IV function areas was 88.4%, 95.5%, 100.0% and 100.0%. Among the 15 districts (counties), 13 had good or fairly good regional acoustic environment quality, taking up 86.7%, up by 33.4 percentage points compared with that of 2008.

7.3.2 Traffic noise

A total of 240 road sections in the cities (towns) of 15 districts or counties were established to monitor traffic noise with a total length of 325.72 km, the traffic noise was monitored 2-4 times.

In 2009, the overall road traffic noise of the resettlement was relatively good with average equivalent sound level at 66.2 dB. The average traffic flow was 1181 vehicles per hour. The total length of trunk road with equivalent sound level over 70 dB was 22.15 km, accounting for 6.8% of the total monitored length. 15 districts (counties) had good traffic noise level, up by 6.7 percentage points compared with that of 2008.

7.3.3 Noise of functional areas

36 monitoring sites were set up in the cities and towns of the 15 districts (counties) to monitor the noise of functional areas, which covered an area of 121.93 km^2. The monitoring was conducted 2~4 days, once an hour.

In 2009, the daytime and night equivalent sound level of the functional areas of the resettlement area was 55.3 dB and 45.0 dB, up by 0.2 dB and down by 0.2 dB respectively compared with that of 2008. The average daytime and night equivalent sound level was 55.2 dB, up by 0.1 dB. 5.6% of hourly equivalent sound level in daytime and 17.7% of hourly equivalent sound level in night exceeded the limit, both of which were lower than that of 2008. Equivalent sound levels for daytime and night in all functional areas met noise standard.

Chapter 8
Monitoring and Studies on Ecological Environment

8.1 Monitoring on Eco–Environment of Wanzhou Model Zone

Standard run-off comparison trial for the study and monitoring of eco-environment of Wanzhou model zone continued in 2009 to monitor soil water content, nutrients and soil erosion under different modes of land use.

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

In 2009, the pattern of compound farming of grain crops, cash crops and fruit trees on ridges of slope farmland (Pattern I) has been developed for 8 years with evident improvement in soil water retention capacity. The findings on comparison trial among Pattern I, 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 as the control pattern) at different soil layers (0~15cm, 15~30cm, >30cm) 2 days, 4 days and 8 days after raining showed that Pattern I enjoys the highest water content on the same day, followed by Pattern II and Pattern III. The comparison of soil water content shows that Pattern I is good to water retention which increased 14.82% on average 2 days after raining, while the average increase of Pattern II was 6.64% as compared with that of the Control Pattern. Soil water content of the same Pattern at different soil layers 2 days and 4 days after rainfall maintained the rule that topsoil has the most water, followed by middle and subsoil. The soil water content after rainfall had the maximum change in Pattern III (control group), followed by Pattern II and Pattern I.

With no or little tillage and the application of three-dimension planting and straw returning to cropland, Pattern I enjoyed obvious improvement in soil physical characteristics and nutrition. In 2009, the porosity of Pattern I increased by 11.44%, its soil particles with diameter between 2~0.02 mm were less than that of Pattern II, while the percent of soil particles in Pattern I with diameter at 0.02~0.002 mm and <0.002mm was smaller than that of Pattern II.

Disregard the amount of rainfall-runoff, Pattern I demonstrated the best result in reducing soil erosion and runoff under different land use patterns on the same monitoring day. Water retention capacity of Pattern II ranked the second, followed by the Control Pattern. Pattern I excelled Pattern II and the Control Pattern in terms of level of nutrients in soil such as organic matter, TN, TP, Kjeldahl nitrogen, quick-acting phosphorus and quick-acting potassium. Nevertheless, the level of total potassium was the highest in the Control Pattern, followed by Pattern II and Pattern I. The concentration of soil particles with diameter below 0.002 mm among eroded soil tended to get lower and lower from the Control Pattern to Pattern II and Pattern I. This proved that Pattern I was most effective in conserving water.

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

Monitoring of water content was carried out respectively on the 2nd day, 4th day and 8th day after

raining day. The results of dynamic monitoring of water content at different soil layers (0-15cm, 15-30cm, >30cm) revealed that on the same monitoring day shaddock-king grass hedgerows (Fence Pattern) had more moisture than flat cultivation of pure grain crops along the slope (Pure Grain Crops Pattern). There was no regularity in water content of different soil layers (surface layer, middle layer and lower layer) under the same land use pattern. Under the Fence Pattern, soil in the hedgerows was the richest in water and there was little change after rainfall. Water content in the upstream and downstream soil of fences was similar, but there was relatively big change in it after rainfall.

Compared with the control group, the concentration of nutrients of the Fence Pattern such as organic matter, TN, TP, TK and Kjeldahl nitrogen increased by 22.19%, 36.36%, 25.73%, 4.58% and 26.19% respectively and the level of quick-acting potassium was 36.34% lower than that of the control group.

The trial showed that Fence Pattern could effectively reduce soil erosion in slope farmland. In 2009, the amount of surface run-off under the Fence Pattern was 5.43 m^3/ ha^2 with eroded soil of 0.0063 t/ ha^2. By contrast, the Pure Grain Crops Pattern saw surface run-off of 271.91 m^3/ha^2 with soil erosion of 0.2597 t/ha^2.

8.2 Monitoring on Ecological Environment of Zigui Model Zone

In 2009, Zigui Model Zone continued its monitoring on water and soil erosion as well as the drain of nitrogen and phosphorus from typical run-off field of the slope land in upstream areas of the Three Gorges Project, studying on the effects of typical land-use pattern on water and soil erosion as well as the drain of nutrients, and identifying the effects of the application of plant fences, stalk & mulch covering and grass coverage on the prevention and control of soil erosion and loss of soil nutrients.

8.2.1 Monitoring on Water & Soil Erosion and Nutrient Drain under Different Land Use Pattern

The slope land run-off of seven precipitations with ≥10 mm was observed from May to September of 2009. Monitoring of the run-off at slope land showed

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that slope land of navel orange orchard had higher run-off coefficient than that of slope farmland (under same slope). Run-off coefficient of groundnut-wheat plot at regular slope farmland was 9.8%, whereas the coefficient of navel orange plots was as high as 17.2%, 7.4 percentage points higher than the former.

Water and soil erosion and N-P loss of the slope land of navel orange orchard was more than that of slope farmland under routine management. Soil erosion of navel orange orchard was 1.7 times higher than that of farmland with similar grade. N-P loss of navel orange orchard exceeded that of farmland of similar slope by 1.9 times and 1.4 times respectively. Monitoring results suggest navel orange orchard suffered from more serious water and soil erosion and N-P loss than that of slope farmland. As the navel orange orchards of the Three Gorges Reservoir area are mainly located in river valleys with an altitude below 500 meters and adjacent to water-level-fluctuating zones, more attention must be paid to prevention and control of soil erosion and nutrient loss.

8.2.2 Monitoring on the Effects of Ecological Measures on the Control of Water & Soil Erosion and Nutrient Loss of Slope Land

The application of plant fence enjoyed most

remarkable effects on the control of the loss of water, soil, and nitrogen & phosphorus nutrients of both navel orange orchards and dry slope cropland. Compared with that of groundnut—wheat plot (control plot), the run-off coefficient of groundnut—wheat with Chinese toon fence plots and groundnut—wheat with alfalfa fence plots dropped by 26.0% and 21.0% respectively; soil loss reduced by 62.7% and 30.5% respectively; slope nitrogen loss went down by 13.7% and 13.9% and phosphorous loss plunged by 77.8% and 6.3% respectively. Protective land use pattern in the naval orange orchard did not have much impact on run-off coefficient during the grafting period. Nevertheless, the soil loss, phosphorus loss and nitrogen loss of navel orange plot interplanted with day lily fence went down by 78.7%, 15.3% and 40.3% respectively as compared with that of navel orange plot without any cover (control plot) and soil loss and slop phosphorous of navel orange plots interplanted with white flower clover was 57.7% and 37.0% respectively.

Compound farming of fruit trees and grass, navel orange orchard interplanted with hedgerows or with straw mulching also helped the control of water & soil erosion, particularly when there was downpour > 40mm, the more intense the rainfall was, the more remarkable the effect was.

8.2.3 Increasing Soil Nutrients by Ecological Measures on the Control of Water & Soil Erosion and Nutrient Loss

A decade of continued trial proves that naval orange orchard interplanted with perennial forage grass and straw mulching could dramatically improve soil nutrients and fertility. Compared with that of naked navel orange plot, the content of organic matter of topsoil of the navel orange plots interplanted with perennial white flower clover or with straw mulching rose by 44.9% and 48.5% respectively. The naval orange orchard interplanted with white flower clover, that with straw mulching and interplanted with day lily all saw increase in TN in soil layer between 0-20cm by 41.6%, 32.7% and 35.4% respectively. Naval orange orchard with straw mulching, interplanted with day lily fence and that interplanted with wheat-groundnut plot enjoyed increase in TP by 58.8%, 55.9% and 52.2% respectively.

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8.3 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 2009.

8.3.1 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 the annual average groundwater level of all observation boreholes ranged from 21.57 m to 22.42 m with annual maximum of 22.14~23.33 m and minimum of 20.63~21.70 m. The annual fluctuation was 0.87~3.22 m. The phreatic surface changed from 19.92~23.14 m and the water table of confined groundwater varied from 20.81 m to 23.43 m with maximum change at 3.22 m and 2.62 m respectively. The average water table lowered compared with that of last year and borehole A had the obvious fluctuation.

Table 8–1 Groundwater table of each observation borehole from Shimatou to Xiaogang Farm of the Honghu Lake in 2009

Unit: m

Boreholes	Confined water table					Phreatic surface				
	A	B	C	D	E	A	B	C	D	E
Annual average	22.42	21.57	21.87	21.65	21.99	22.12	22.40	22.16	22.00	22.01
Maximum	23.43	22.29	22.67	22.35	22.68	23.14	23.06	22.67	22.40	22.78
Minimum	21.15	20.81	20.88	20.81	21.61	19.92	21.61	21.52	21.53	21.62
Change	2.28	1.48	1.79	1.54	1.07	3.22	1.45	1.15	0.87	1.15

The monthly average of the phreatic surface of all phreatic surface boreholes was 21.01-22.91 m and the water table of all observation boreholes for confined groundwater ranged from 21.08 m to 23.00 m. Monthly average water table peaked from July to August and the lowest water table appeared in January and February, mostly concentrating on January. High water table period occurred during May-September and low water table from October to March. Water table fluctuations indicate this year's high water table period was shorter than that of the previous year. Groundwater table dropped rapidly after September.

8.3.2 Monitoring on Indicators of Soil Gleization

In 2009, 8 soil monitoring sections were arranged from Xiaogang Farm to Shimatou in order to continue the monitoring of such indicators as soil moisture, pH, oxidation reduction potential, the total amount of reduction material, active reduction materials and the level of ferrous iron of the soil. The monitoring was conducted once in the winter and once in summer.

Monitoring results showed that the total amount of reduction materials was 0.21~9.21 centimol/kg with the average at 2.07 centimol/kg. The concentration of active reduction materials was 0.19~6.63 centimol/kg with the average at 1.36 centimol/kg. The ferrous concentration was 0.03~0.78 centimol/kg with average at 0.22 centimol/kg. Compared with that in 2008, there was some decrease of the total concentration of reduction materials, active reduction materials and ferrous iron and the measured data in summer showed bigger reductions.

8.4 Comprehensive Monitoring of Ecological Environment of the Estuary of the Yangtze River

8.4.1 Water-salt Movement

In 2009, dynamic monitoring work at the estuary (land-sea interface) continued to focus on the monitoring on dynamic change of salt concentration of the water. Three monitoring sections were established at 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, soil negative pressure, groundwater table and groundwater conductivity.

In 2009, the dynamic change pattern of the conductivity of the water of the Yangtze River and inland rivers at each section at the estuary area was similar within 2009. Water-salt related indicators of Yinyang Section near the river mouth recorded the highest. Monitoring results of Daxing Section and Xinglongsha Section were varied.

● **Water Conductivity of the Yangtze River**

The change patterns of water conductivity of Yinyang Section, Daxing Section and Xinglongsha Section were similar with gradual drop of conductivity since April and evident growth since September. Compared with that of 2008, the annual average was lower. Conductivity of Yinyang Section was mostly lower than that of the same period of 2008 except that in March. Conductivity

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of Daxing Section in September and October rose by 20.1 and 21.0 percentage points respectively compared with that of the same period of 2008. The conductivity of Xinglongsha Section reached its high in autumn and winter. Conductivity of Yinyang Section, Daxing Section and Xinglongsha Section went lower as their distance to the estuary of the Yangtze River grew further.

● **Groundwater Table**

In 2009, the dynamic change pattern of the groundwater table of all sections in the estuary area was basically the same, relatively low in the autumn, but high in the summer. Groundwater depth of Yinyang, Daxing and Xinglongsha Sections went down by 3.2-15.6% compared with that of 2008. The groundwater table of Yinyang and Daxing Sections were about the same with monthly average going slightly higher in summer and lower in autumn. Groundwater table of Xinlongsha Section was quite low in spring and autumn and began to increase after November.

● **Groundwater Conductivity**

The yearly average of groundwater conductivity of Yinyang Section hovered around historical low while the conductivity of Xinglongsha Section in September reached historical high of the past years. Big fluctuation was found in groundwater conductivity of Daxing Section. Compared with that of the previous year, the yearly average of groundwater conductivity of both Yinyang and Daxing Sections had dropped a little whereas groundwater conductivity of Xinglongsha Section from June to December was lower than that of the same period in 2008. Groundwater conductivity was basically inverse proportion to the distance between monitoring sites and the Yangtze River bank and showed significant correlation to salinity of soil layer between 20 and 40cm.

● **Conductivity of Inland River**

The changing pattern of conductivity of inland river at Yinyang Section in spring resembled that of 2008, hitting historical high in April. Conductivity at Daxing Section began to rise since September and reached the peak of the second half year in winter. The change pattern of conductivity at Xinglongsha Section was similar to that of previous years. Compared with that of 2008, inland river conductivity of Yinyang Section dipped a little, that of Daxing Section was parallel to the previous year and conductivity at Xinglongsha Section demonstrated a marked descending trend. The conductivity of inland river had close relationship with the conductivity of the Yangtze River. There existed high positive correlation between conductivity of inland river at all the estuary monitoring sections and that of the Yangtze River.

● **Soil Conductivity**

Salt accumulation has been growing in recent years in the topsoil of Yinyang Section. Its soil conductivity began to climb since August and reached historical high in autumn and winter. Desalinization pattern was found in the soil of Daxing Section in recent years and there was no evident change in its soil conductivity in autumn and winter as compared with that of 2008. Soil conductivity of Xinglongsha Section recorded a little fluctuation and the overall level was the minimum in historical years. Soil conductivity of Yinyang Section

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rose by 3.5% annually on average compared to that of 2008 and that of Daxing and Xinglongsha Sections has dropped. In general, the shorter the distance between monitoring sections and the bank of the Yangtze River was, the higher the soil conductivity.

8.4.2 Non-biological Environment of the Waters

● **Hydrology**

In May 2009, water temperature of the Yangtze River estuary waters was high in the west and low in the east, averaging between 16-21℃. Compared with that of 2007, the average water temperature was similar with some change of spatial distribution. In November 2009, water temperature in estuary waters was low in near coast and high in off coast, low in surface layer and high in bottom layer. Compared with that of 2007, water temperature in near coast dropped by 5.0℃ and down by 1.0℃ in off coast. The seasonal difference was attributed to meteorological factors and seasonal change and interaction among various currents (Changjiang diluted water and Taiwan warm current, etc.).

With the increase of inflowing run-off to the Yangtze River, the surface salinity of the whole waters in May 2009 was below 28.0. The maximum salinity (33.7) fell by 0.3 as compared with that of 2007. In November, influenced by Changjiang diluted water and the surface water of Taiwan warm current, the overall salinity exhibited a pattern of low salinity in near coast waters and high in off coast waters. The minimum appeared at northwest of the Yangtze River estuary (river water) which was lower than 3.0 while the maximum, measured as 34.0, was found in southeast waters. There was some difference in perpendicular distribution of salinity, which was even in the inland waters of the estuary and low in the surface and high at the bottom of southeast waters (seawater). The maximum salinity went down by 0.1 compared with that of 2007.

● **Water Chemistry**

In 2009, the average level of dissolved oxygen descended dramatically from the Yangtze River estuary to the coastal waters. The dissolved oxygen of inland waters was lower than that of 2007 in May and higher in November. In seawaters, the concentration of surface layer became higher than that of 2007 in May and lower in November. The average level of dissolved oxygen of bottom layer in both May and November has posted sharp rise.

In May and November, 2009, pH value in the surface and bottom layer of the Yangtze River estuary differed little from each other and formed a pattern of low pH value in near coast waters and high in off coast waters. The pH value in both May and November dropped compared with that of 2007.

In May 2009, the concentration of chemical oxygen demand (COD) in waters of the Yangtze River estuary was high at the estuary and near coast waters and low in off coast waters and the level was higher than that of November. COD in both inland waters and seawater has increased compared with 2007.

In 2009, concentration of phosphate, silicate, nitrate, TN and TP in waters under investigation showed evident difference from place to place, i.e., the concentration was high in inland waters and near the estuary and gradually decreased in off-coast waters. The distribution of nitrite and NH3-N was complicated. Compared with 2007, average level of phosphate and TP in 2009 was high and that of silicate and TN was low. Changing patterns of nitrate and nitrite varied in different waters.

● **Sediment**

The average concentration of suspended matter at the estuary under investigation was 77.0 mg/l and 81.1mg/l in May and November of 2009 respectively. Compared with 2007, the level of suspended matter in May increased while that in November dropped.

The concentration of organic particles at the estuary waters under investigation was higher in May (spring) than that of November (autumn) in 2009. The average loss on ignition (LOI) of suspended sediment in May was 10.3mg/l, doubled the amount of May 2007, and the average LOI in November 2009 was 5.3mg/l, less than half of the amount of the same period of 2007.

8.4.3 Biological Environment

● **Chlorophyll-a**

In May 2009, the concentration of chlorophyll-a of the estuary waters was 1.67 μg/L, which was much higher that of the same period in 2007. The value of November 2009 was 0.43 μg/L, lower than the corresponding data

in 2007.

● **Zooplankton**

In 2009, altogether 109 species or biomes of zooplankton were identified in the waters under investigation. There is no obvious change in the number of species compared with that of 2007, but the average abundance declined remarkably.

In May 2009, a total of 788 fish zooplankton under 19 species were caught including such dominant species as Coilia mystus, anchovy, Gobiidae and songjiang sculpin. Compared with that of 2007, the abundance and number of species have increased.

In November 2009, a total of 232 fish zooplankton under 12 species were caught. Fish eggs accounted for the majority and other dominating species included Thryssa kammalensis. Compared with 2007, both the abundance and the number of species of fish zooplankton have decreased.

● **Zoobenthos**

In May and November 2009, altogether 152 species of biological samples were obtained in the waters under investigation. Among them, Polychaetes ranked the first in terms of species amount, followed by Mollusca. Crustacean and Echinodermata had fewer species. In specific, the number of species of zoobenthos caught in May totaled 110 and that in November was 93.

8.4.4 Fishery Resources

In 2009, both the species amount and abundance of fishery resources of the estuary of the Yangtze River were higher than the same period of 2007 with some improvement of ecosystem biodiversity but still less than that of the years before the impoundment. In the spring, *Pseudosciaena polyatis* still maintained dominance and *Lepidotrigla abyssalis* became dominating species for the first time. Medusae disappeared in invertebrate species. *Loligo japonica* and Portunus trituberculatus continued their dominance. The amount of Trachypenaeus curvirostrisk kept on growing. In autumn, the species amount and abundance of fishery resources of Yangtze River estuary dropped compared with that of 2007 and Bombay duck rose to the top dominance. *Pseudosciaena polyatis* lost its superiority and was replaced by Setipinna taty. The number of invertebrate skyrocketed and Trachypenaeus curvirostris and Portunus trituberculatus grew into the top dominant species.

8.5 Monitoring of Ecological Environment of Water-level-fluctuating zone

8.5.1 Soil Physical and Chemical Properties

(GB15618-1995) Monitoring of soil physical and chemical properties was carried out from 2008 to 2009 at the natural growth area and biological control area (Regulating dam of Kaixian County and Fengjie County, vegetation rehabilitation area of Zhongxian County and Zigui County) of water-level-fluctuating zone based on the Grade I standard of Environmental Quality Standard for Soils (GB15618-1995).

The findings of the analysis on the change of heavy metal and nutrient level of natural growth area and biological control area in 2009 show that heavy metal level in the soil of downstream dam was higher than that of upstream dam with the concentration of As, Cr, Pb, Cu, Mn and Cd rising by 28.16%, 1.63%, 6.12%, 44.53%, 14.62% and 57.83% respectively, whereas the level of Hg, Zn and Fe dropped by 34.37%, 5.05% and 16.09% respectively. Some nutrients including organic matter, TN, TP and nitrate nitrogen in the soil of downstream dam increased by 55.29%, 28.22%, 5.44% and 8.41% respectively compared with that of upstream dam, while the concentration of total potassium, available phosphorous, available potassium and ammonium nitrogen reduced by 10.37%, 46.03%, 38.67% and 6.19% respectively. The level of heavy metal and nutrients in vegetation rehabilitation area was higher than that of natural growth area. Among them, Hg, As and Cr increased by 140.63%, 64.44% and 103.93% respectively, Cd by 43.79%, Pb by 48.02%, Cu by 54.76%, Zn by 52.47%,Fe by 52.90% and Mn by 29.06%. The level of organic matter, TN, TP, and TK jumped by 118.40%, 100.78%, 45.48% and 44.61% respectively, AP, AK, ammonium nitrogen and nitrate nitrogen rose by 121.30%, 55.28%, 60.75% and 108.51% respectively.

8.5.2 Natural Rehabilitation of Vegetation in Water-level-fluctuating Zone

In 2009, investigations were conducted on the plant

communities in 149~179 m water-level-fluctuating zone of the Three Gorges Project area. Fixed monitoring sites set up in 2007 in typical water-level-fluctuating zone at Shibaozhai, Zhongxian County, Chongqing Municipality, which was to the northern bank of the mainstream of the Yangtze River also underwent reexamination. The investigations covered 99 quadrats of 9 sample belts, starting from 149 m with each quadrat set up every 3 meters higher.

Monitoring results indicate the current vegetation in the water-level-fluctuating zone of Zhongxian County was mostly thick growth of grass with some brushwood and small forest in areas not yet submerged. Impoundment had obvious impact on plant communities, especially water-logged areas where community structure and species composition were simple and biodiversity poor. With increase of elevation and decrease of water-logging, biodiversity gradually got richer and richer.

Currently, biodiversity of the water-level-fluctuating zone in Zhongxian County was on the rise during the succession of plant community with more species introduced than that moving out. The main reason was because most land in the water-level-fluctuating zone was abandoned arable land and the plant communities were still in the early stage of succession. In spite of intense change of plant communities and frequent movement of species across different quadrats, the number of removed and introduced species was not large, given the size of the whole quadrats.

In November 2008, trial impoundment of the Three Gorges Reservoir reached 172 m and by the middle of June 2009, the water level retreated to 145 m. Distinct characteristics could be found in the distribution of vegetation type in the water-level-fluctuating zone as the time period of waterlogging differed (Photo a). Area with long waterlogging had simple vegetation type and low coverage. By August 2009, the vegetation coverage in water-level-fluctuating zone had relatively big increase, blurring the division of different vegetation types. This indicates certain resilience and maintenance ability of plant communities in the water-level-fluctuating zone.

In 2009, the existing vegetation of water-level-fluctuating zone was mostly herbaceous plants. Biodiversity in submerged natural flood land was richer than that of waterlogged arable land (Photo b). The latter was mainly covered by scrubby herbage with little variety (Photo c). With rise of elevation, the period of water-logging of water-level-fluctuating zone gradually went down with rise of biodiversity. However, vegetation rehabilitation in the steep slope area was not optimistic due to strong scouring and thin soil layer (Photo d). In addition, this part of area was on both bank of the mainstream, it has affected reservoir landscape to some extent.

8.5.3 Experiment of Vegetation Rehabilitation at Water-level-fluctuating Zone

The experiment base at the water-level-fluctuation zone of Lanling Creek covered an area of 30 mu (1 mu = 667 m^2) planted with 18 species of plants including woody plants (about 21200 plants) and herbage plants (exact number was not available due to biological characteristics) under trial. Vegetation rehabilitation trial was conducted in 4 sections at different elevation of the water-level-fluctuating zone according to their biological characteristics.

Plant communities growing between 175-180m of the water-level-fluctuating zone belonged to transitional type from vegetation of the water-level-fluctuating zone to terrestrial communities, they were usually not submerged by river water. So plants with strong anti-drought capacity and anti-water-logging were selected for the trial. By far the plants on trial in this section are growing well with 100% survived and overall vegetation coverage about 65%.

New navel garden

(a) Vegetation rehabilitation of natural water–level–fluctuating zone in Kaixian County

(b) Natural water–level–fluctuating zone with gradual slope in Kaixian County

(c) Water–level–fluctuating zone at cropland of Yunyang County

(d) natural water–level–fluctuating zone with steep slope in Wushan County

The water-level-fluctuating zone at 172-175 m was waterlogged and revealed alternatively from time to time. Therefore, the selected plants were tree plants, shrub plants and herbage plants with strong anti-water-logging and drought capability. At present this section has not yet submerged and the plants on trial are growing well with survival rate at 100% and vegetation coverage around 60%.

Water-level-fluctuating zone at 156-172 m was all submerged during the low water period of the Yangtze River. Thus, native shrub plant and herbage plant species with strong anti-water-logging and anti-drought capabilities were selected for trial. Vegetation of this section was partly or all submerged between September and May of the next year. Now the plants on trial grow well with total coverage about 55%.

Water-level-fluctuating zone at 145-156 m was under long-term inundation throughout the year with harsh conditions for plant growth. Therefore, native shrub plant and herbage plant species with the strongest resistance to water-logging and drought were chosen. Vegetation at this section was submerged from September to May of the next year with coverage only standing at 10% approximately.

8.6 Monitoring of Commercial Fish Species of Reservoir Area

In June 2009, among the four monitoring sections in the lower reaches of Wujiang River, 9 species of fish were caught in Pengshui Section, 7 species in Jiangkou Section, 7 in Wulong Section and 6 in Baima Section. The most common species caught at Pengshui

Section were *Coreius heterodon, Gobiobotia filifer and Rhinogobio cylindricus Gunther. Siniperca kneri Garman* was mostly found at Jiangkou Section; *Coreius heterodon, Gobiobotia filifer* and *Glyptothorax sinense* at Wulong Section. *Silurus meriaionalis Chen* and *Ctenopharyngodon idellus* were the common catch at Baima Section.

The cumulative weight of around 20 species of commercial fish caught in the four monitoring sections accounted for 91.0% of the total, which included carp, *Pseudobagrus vachelli, Mystus macropterus, Silurus meriaionalis Chen, Carassius auratus, Rhinogobio typus, Pseudogyrincheilus procheilus, Saurogobio dabryi, Coreius heterodon, Leiocassis crassilabris Gunther, Hemiculter leucisculus, Siniperca kneri Garman, Ctenopharyngodon idellus, macular hemibarbus, Zacco platypus, Garra pingi*, Siluriformes, *Rhinogobio cylindricus Gunther*, *Onychostoma sima* and *Tor yunnanensis*. 16 species took up 87.9% of the total tail amount including *Pseudobagrus vachelli, Saurogobio dabryi, Hemiculter leucisculus, Pseudogyrincheilus procheilus, Carassius auratus, Zacco platypus, Leiocassis crassilabris Gunther, macular hemibarbus, Mystus macropterus, Rhinogobio typus, Gobiobotia filifer*, carp, *H.sauvagei, Onychostoma sima, Rhinogobio cylindricus Gunther* and *Siniperca kneri Garman*.

Calculating by weight, the number of fries weighing less than 50g accounted for 80.8% of the total catches and their weight made up 35.6% of the total. Fries with weight 51 ~ 200 g consisted of 15.7% of the total and their weight accounted for 31.8%. Fish weighing more than 500g accounted for 12.5% of the total weight.

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China National Environmental Monitoring Center

Compiling Members:

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Geological Hazardous Monitoring Center of the Three Gorges Reservoir, Ministry of Land and Resources
Environmental Protection Center of the Ministry of Communications
Water Conservation Committee of the Yangtze River
Office of the Fishery Resources Management Committee of the Yangtze River
Agriculture Ecological and Environmental Protection Station of Hubei Province
Chinese Center for Disease Control and Prevention
Ecological and Environmental Monitoring Center of the State Forestry Administration
Institute of Hydrobiology, Chinese Academy of Sciences
Institute of Remote Sensing Applications, Chinese Academy of Sciences
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Institute of Oceanology, Chinese Academy of Sciences
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Institute of Mountain Hazards and Environment, Chinese Academy of Sciences
Institute of Botany, Chinese Academy of Sciences
National Climate Center, China Meteorological Bureau
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