

Chapter 2

Characteristics of the Study Area

Abstract Miyun County is the largest rural suburb and the most important county of Beijing. Miyun County has a unique significance for the regional environment, and dramatically influences the water safety and local development of Beijing. In the catchment areas of Miyun Reservoir, stockbreeding wastes are generated and heavily contribute to water pollution, especially pig farming, which has become the source of the most serious pollutants of Miyun Reservoir. In this Chapter, the characteristics of the Miyun County, Miyun Reservoir, and the study area, and the current environmental conditions are presented.

Keywords Miyun County · Miyun Reservoir · Characteristics

2.1 Development of Stockbreeding Industry and Its Pollution in Beijing

2.1.1 Natural Geographical Environment

Beijing is the capital of China and the political and cultural centre of China. it is located at latitude between 39°26' and 41°03'N and longitude between 115°25' and 117°30'E. It lies in the north of China and covers an area of 16.8 thousand square kilometers. January, with an average temperature of -4.7°C , is the coldest month and July, with an average temperature of 26.1°C , is the hottest month. The rural areas of Beijing consists of 10 rural areas about 15,800 and 10,930 km^2 is agricultural land.

The total population of Beijing is 11.2 million in 2007, and the density of population is 668 people per km^2 , which is more than 5 times of the average level of China. The population of rural resident is 8.83 million, which accounting for 78.8 % of the whole city population and leading to the huge pressure.

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Beijing Natural channel consists of five water systems from west to east: Jumahe River water system, Yongdinghe River water system, Beiyunhe water system, Chaobai River water system, Jiyunhe water system. There are no natural lakes in Beijing. There are 85 reservoirs, of which Miyun Reservoir and Guanting Reservoir, Huairou Reservoir, Haizi Reservoir are large reservoirs. Miyun Reservoir is the only surface water resource of Beijing.

2.1.2 Development of Stockbreeding Industry in Beijing

The gross output value of stockbreeding industry was 12.36 billion RMB Yuan in 2005, which accounted for 45.78 % of the total agricultural output value (Fig. 2.1). And the gross income of stockbreeding industry was 9.57 billion RMB in 2005, which accounted for 45 % of total agricultural income (Fig. 2.2). The population

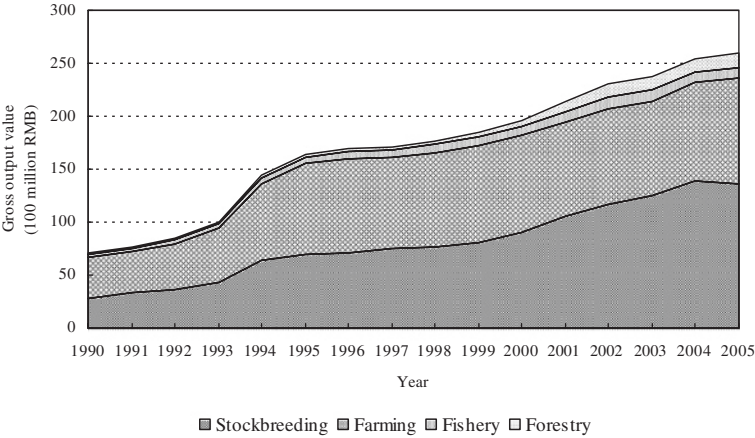


Fig. 2.1 The gross output value of farming, forestry, stockbreeding and fishery industry (1990–2005). *Source* Beijing Statistics (2006), pp 23–24

Fig. 2.2 The distribution of the first industry production in rural areas of Beijing (2005) *Source* Beijing Statistics (2006), pp 8–10

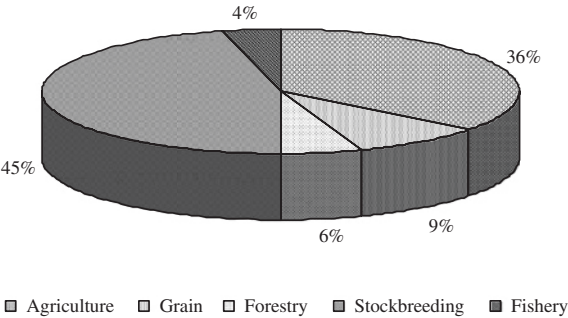


Table 2.1 The number of stockbreeding animals (2005)

Number of stockbreeding	Number
Beef cattle slaughtered in the whole year	24.5
Pork pigs slaughtered in the whole year	448.7
Sheep slaughtered in the whole year	256.1
Livestock on hand (year-end)	3,125.1

Source Beijing Statistics (2006), pp 18–19
Unit: 10,000 heads

Table 2.2 The output of stockbreeding products (2005)

Output of stockbreeding products	Output
Output of meat	66.7
Pork	31.3
Beef	4.4
Mutton	4
Cow milk	64.2
Poultry eggs	16
Eggs	15.6
Honey	3,282

Source Beijing Statistics (2006), pp 16–17
Unit: 10,000 t

engaged in stockbreeding industry was 77,042 people in 2005, which solving the employment problem nearly 100,000 people.

Table 2.1 represents the number of stockbreeding animals in 2005. The number of Large Animals on hand (year-end) was 266,000 heads; Pork Pigs Slaughtered in the whole year was 4,487,000 heads; Beef Cattle Slaughtered in the whole year was 245,000 heads; Sheep Slaughtered in the whole year was 2,561,000 heads; Livestock on Hand (year-end) was 31,251,000 heads in 2005.

Table 2.2 indicates the gross output of stockbreeding waste was 3 million tons in 2005. There are two treatment methods of stockbreeding waste: (1) majority of the wastes are treated by dry haul treatment method; (2) the method of water jetting concentrated in large-scale breeding farm. The general utilization method of stockbreeding waste is returning to the stockbreeding waste to the field, and the adoption of infiltration to treat the sewage discharge.

2.1.3 Environmental Pollution Caused by Stockbreeding Wastes

According to sewage capacity coefficient that calculated by the State Environmental Protection Administration (2002), the gross output of stockbreeding waste was 3,044,200 t in 2005, the total net load of COD was 93,400 t, T-N was 18,500 t and T-P was 7,000 t, respectively (Table 2.3).

Table 2.3 Water pollutants emitted by stockbreeding wastes (2005)

Water pollutants	Pollutant
COD	93,400
T-N	18,500
T-P	7,000

Source Beijing Statistics 2006, pp 57–59
Unit: t

Table 2.4 Air pollution emitted by stockbreeding wastes (2005)

Air pollutants	Pollutant
N ₂ O	1,125.3
CH ₄	64,209.54
NH ₃	38,647.87

Source Beijing Statistics 2006, pp 57–59
Unit: t

According to IPCC (2006) standards, the emission of air pollution of N₂O that caused by stockbreeding waste was 1,125.3 t/year, NH₃ was 38,647.87 t/year, CH₄ was 64,209.54 t/year, respectively (Table 2.4).

The average loading quantity of stockbreeding waste in the cultivated land of the rural areas of Beijing has reached 30.9 t per 10,000 m². Comparing with the situation in the suburbs of Shanghai and Zhejiang Province, the inequality extent of Beijing is more serious than other big cities.

2.1.4 Potential Value of Biomass Resource of Stockbreeding Wastes

There is massive utilizable nutrition in stockbreeding wastes biomass, including nutrients of N, P and K. And all the utilizable nutrition can be utilized as biomass resource that is very effective and useable to land and farming by proper treatment methods.

2.2 Miyun County and Miyun Reservoir

2.2.1 The Importance of Miyun County and Miyun Reservoir

Miyun County is the largest suburb and the most important county of Beijing with an area of 2,229 km² and about 426 thousand people. The gross regional product (GRP) was about 5,126 million RMB Yuan in 2006. Especially Miyun Reservoir, the only surface water resource of Beijing, provides more than 60 % of the water resources for Beijing. Miyun Reservoir, located 100 km northeast of Beijing City,

Table 2.5 Physical dimensions of Miyun reservoir

Surface area	188 km ²
Volume	0.4375 km ³
Maximum depth	43.5 m
Catchment area	15,788 km ²

Source Miyun County Statistics (2007), pp 14–15

is a mountain valley reservoir. It was built in September of 1960, and is the largest reservoir in Beijing area. Two main rivers, Chao River and Bai River, flow into Miyun Reservoir. The total catchment is about 15,788 km², consists of mountains and piedmonts and lacks large industrial enterprises. Sediments and nutrients from agricultural, pastoral and forestry lands that enter the reservoir with overland flow make the main pollution sources (Table 2.5).

The initial purpose of building Miyun Reservoir was flood control, irrigation and fishery, but it has become more and more important as main drinking water storage for Beijing area. The water quality is therefore of great importance. Recently, the nutrient concentration and the number of phytoplankton in the Reservoir are constantly rising to arrest the attention of Beijing municipality. A project for keeping the water clean is being put into effect.

This important ecological value of Miyun County has unique significance for the region’s environment and dramatically influences water quality and local development in Beijing.

2.2.2 The State of Water Environment in the Catchment Area

Though T-N (total nitrogen), T-P (total phosphorus) and COD (chemical oxygen demand) contents of the lake water are low, the population densities of plankton and benthic invertebrates have increased as compared with those in 1981, indicating a trend toward eutrophication. The concentration of COD and T-N gradually increased during the year from 1994 to 2006.

Stockbreeding wastes in the catchment areas of Miyun Reservoir contribute heavily to water pollution. Figure 2.3 shows the detailed structure of water pollutants of the catchment area of Miyun Reservoir, the amount of T-N emitted by pig farming industry accounted about 25 % of total amount of T-N. About 41 % of T-P and 36 % of COD were emitted by pig farming industry (Figs. 2.4, 2.5). Therefore, pig farming industry has become the source of the most serious pollutants to Miyun Reservoir.

Future development of Miyun County and decreases in annual runoff to Miyun Reservoir are expected to significantly influence the regional environment and the water quality of Miyun Reservoir worsen, leading to a serious water safety crisis for Beijing.

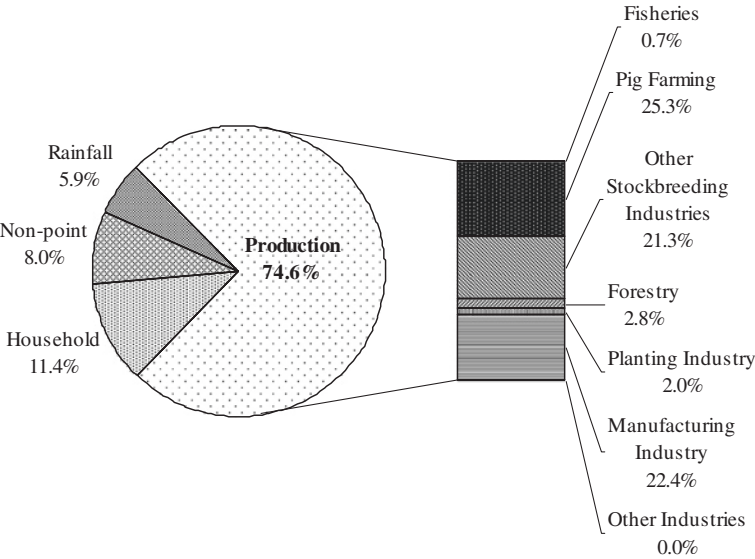


Fig. 2.3 Proportion of the net load of T-N in the catchment area. *Source* Miyun County Statistics (2007), pp 16–17

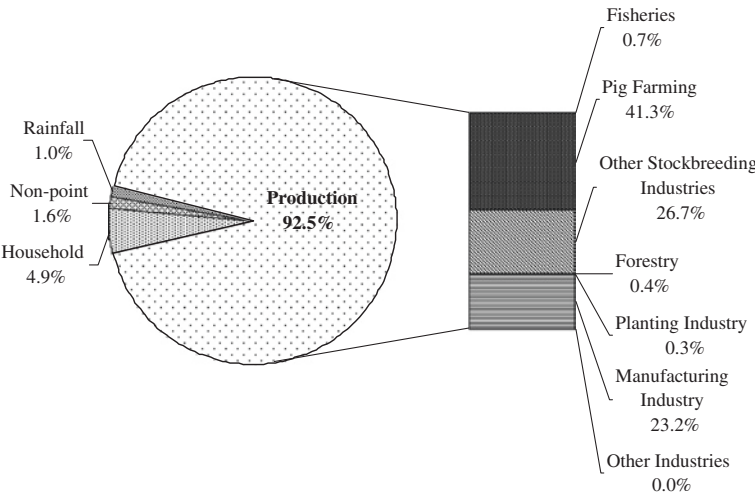


Fig. 2.4 Proportion of the net load of T-P in the catchment area. *Source* Miyun County Statistics (2007), pp 16–17

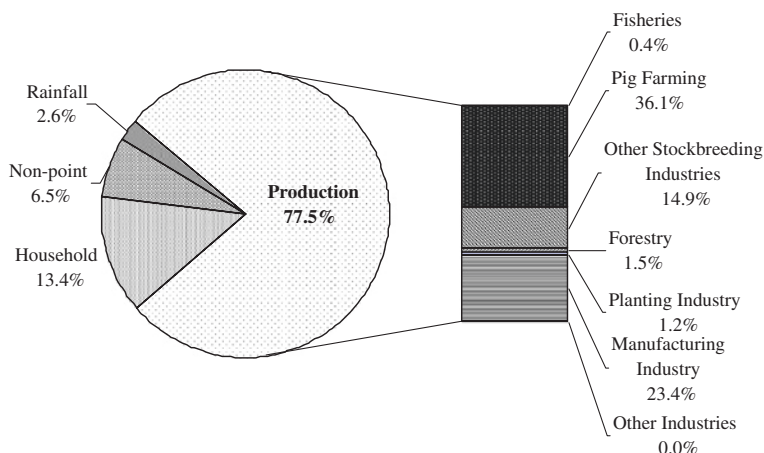


Fig. 2.5 Proportion of the net load of COD in the catchment area. *Source* Miyun County Statistics (2007), pp 16–17

2.2.3 The State of Water Environmental Management in the Catchment Area

Since Miyun Reservoir is one of the most important water sources for Beijing, fishery may be allowed with certain limitation as long as it causes no harm to water quality. Water recreations are all forbidden. In the catchment area, water and soil conservation practices are encouraged.

The catchment area introduced wet methane fermentation technology and composting to treat serious water pollutants emitted by the stockbreeding industry. The government also proposed and provided preferential prices for farmers to promote utilization of organic fertilizer. In order to conserve water and soil for the Miyun Reservoir, the local government also considered the policies of a water conservation forest to conserve water resources for the reservoir and minimize pollutants indirectly based on the requirements of the region.

On the other hand, in order to satisfy the demand for animal products of Beijing and improve the local economic development, the policy of “Strong Stockbreeding County” has been raised by Miyun government. It is can be expected that the stockbreeding industry would dramatically increase in the future 5–10 years which would result in the serious environmental pollution without proper treatment methods for stockbreeding wastes. There is no reason to think that we must deteriorate the socio-economic activity level to improve the quality of environment.

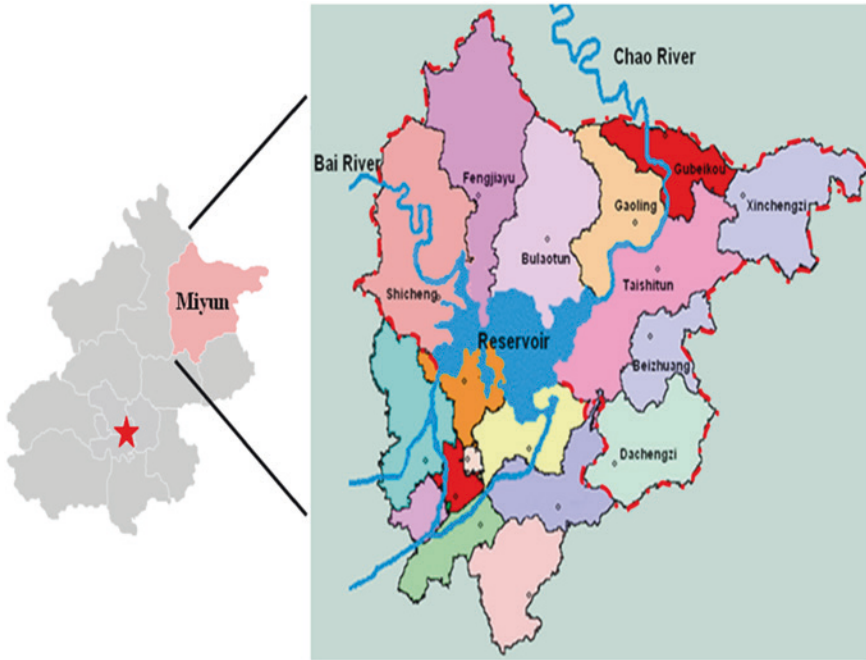


Fig. 2.6 Location of the study area

2.3 Study Area: The Upstream Area of Miyun Reservoir in Miyun County

The study area covers the upstream area of Miyun Reservoir in Miyun County. In this study area, there are nine towns of Miyun County. Two main rivers, Chao River and Bai River flow through the nine towns into Miyun Reservoir (Fig. 2.6). There area 12.9 thousand people in the study area. The gross regional product (GRP) was about 1,948 million RMB Yuan in 2006 which accounted about 38 % of the total GRP of Miyun County.

2.3.1 Classification of Sub-basins of the Main Rivers and Water Pollutant Sources

The Chao and Bai rivers are the main rivers flowing into the Miyun Reservoir. The two rivers flow through nine towns of Miyun County. These rivers are structured into the model, and other small rivers in the sub-basins flow into one of these two major rivers (Table 2.6). We measured three indicators of water pollution, including T-N (total nitrogen), T-P (total phosphorous) and COD (chemical oxygen demand) (Table 2.8) (Yan et al. 2010b).

Table 2.6 Classification of the study area

Region index	Rivers		Towns	
	Index	Name	Index	Name
1	1	Bai river	1	Shi cheng
			2	Feng jiayu
			3	Bu laotun
2	2	Chao river	4	Gao ling
			5	Gu beikou
			6	Xin chengzi
			7	Tai shitun
			8	Bei zhuang
			9	Da chengzi

Table 2.7 Population of the study area in 2005 and 2006

Basin	Index	Town name	2006	2005	Variation
Bai river	1	Shi cheng	5,522	5,647	−125
	2	Feng jiayu	9,266	9,799	−533
	3	Bu laotun	23,478	23,937	−459
	Total of Bai river basin		38,266	39,383	−1,117
Chao river	4	Gao ling	17,837	17,736	101
	5	Gu beikou	8,226	8,478	−252
	6	Xin chengzi	12,223	12,341	−118
	7	Tai shitun	26,598	27,024	−426
	8	Bei zhuang	8,543	8,443	100
	9	Da chengzi	16,959	17,168	−209
	Total of Chao river basin		90,386	91,190	−804
Total of the catchment area			128,652	130,573	−1,921

Source Miyun County Statistics (2007), pp 10–11
Unit: person

2.3.2 Regional Socio-economic Status of the Study Area

Although the upstream area of Miyun Reservoir is the most important area of Miyun County, the gross regional product (GRP) of the study area was about 1,948 million RMB Yuan in 2006 which accounted about 38 % of the total GRP of Miyun County. The total population of the study area was about 12.9 thousand in 2006 and it decreased about 1.47 % as compared to the population in 2005 (Table 2.7).

In this area, Chao River Basin is the larger basin occupying 50 % of the total area in the whole basin. Approximately 90,000 people live in the basin indicating about 70 % of total population of the study area. About 79.5 % of the total output value was produced by Chao River Basin.

Industry in study area is classified according to fisheries, pig farming industry, other stockbreeding industry, forestry, planting industry, manufacturing industry and other industries as shown in Table 2.8. From this table we can conclude that

Table 2.8 Output value of industries in the study area of 2006

Basin	Index	Town name	Total output value	Fisheries	Pig farming industry	Other stock-breeding industries	Forestry	Planting industry	Manufacturing industry	Other industries
Bai river	1	Shi cheng	14,526	399	212	2,330	832	135	6,280	4,337
	2	Feng jiayu	28,162	70	780	5,058	792	747	17,372	3,343
	3	Bu laotun	45,022	1,238	3,726	6,937	798	1,411	23,160	7,753
Chao river	Total of Bai river basin		87,710	1,707	4,719	14,325	2,422	2,293	46,812	15,433
	4	Gao ling	43,223	240	4,080	5,993	907	1,420	23,610	6,974
	5	Gu beikou	22,518	100	1,194	2,670	598	289	10,515	7,153
	6	Xin chengzi	41,593	160	1,370	2,883	581	1,164	23,472	11,964
	7	Tai shitun	120,419	1,306	2,813	7,695	1,799	2,272	77,303	27,231
	8	Bei zhuang	68,071	319	1,591	9,321	603	477	52,485	3,274
	9	Da chengzi	43,874	399	1,979	4,511	653	985	31,100	4,246
Total of Chao river basin			339,698	2,523	13,027	33,072	5,142	6,607	218,485	60,842
Total of the catchment area			427,408	4,230	17,746	47,396	7,564	8,900	265,297	76,275

Source Miyun County Statistics (2007), pp 12–13
Unit: 10,000 RMB Yuan

Table 2.9 The area of different land use in 2006

Basin	Index	Town name	Upland cropping	Forest land	Orchard land	City area	Other land area	Total area
Bai river	1	Shi cheng	0.75	17.75	1.51	34.65	8.35	63.01
	2	Feng jiayu	2.38	17.48	9.13	25.06	8.60	62.65
	3	Bu laotun	4.72	16.14	25.31	1.49	2.03	49.69
	Total of Bai river basin		7.85	51.37	35.95	61.20	18.97	175.35
Chao river	4	Gao ling	7.16	11.23	20.41	1.24	1.39	41.42
	5	Gu beikou	2.47	12.71	2.13	7.23	4.37	28.91
	6	Xin chengzi	6.03	8.86	14.54	6.58	7.83	43.83
	7	Tai shitun	7.37	24.30	27.97	1.88	1.07	62.59
	8	Bei zhuang	3.07	9.12	4.54	5.39	4.85	26.97
	9	Da chengzi	2.92	9.43	11.02	12.92	6.77	43.05
	Total of Chao river basin		29.01	75.65	80.60	35.23	26.28	246.77
Total of the catchment area			36.86	127.02	116.55	96.44	45.25	422.12

Source Miyun County Statistics (2007), pp 8–10

Unit: km²

manufacturing industry is the most important economic activity in the study area, which contributed about 62 % of the total output value in 2006. However, the local government has already raised the policy to reduce and limit the scale of manufacturing industry in order to protect the environment of upstream area of Miyun Reservoir. Pig farming industry and other stockbreeding industry are also important economic activities in the study area, which accounted about 4 and 11 % of the total output value of the area respectively. With the demand for animal products and a policy of “Strong Stockbreeding County” by Miyun government, the production of stockbreeding industry would dramatically increase in the future.

Land use in the study area is classified into five categories, including upland cropping, forest land, orchard, city area and other land area as shown in Table 2.9. It is concluded from the table that, distribution of the land use pattern is different in terms of upland cropping, orchard and city area in basins. City area are mainly be occupied by Bai River Basin. In addition, Miyun government has already raised the policy of Organic Fertilizer Promotion Policy in 2004 and converted majority of upland cropping into forest land to improve water conservation function of Miyun reservoir, the area of forest land accounted about 30 % of the total area in the study area in 2006.

2.3.3 Total Pollution in the Study Area

The total amounts of pollutants flowing into the study area were estimated using official data provided by the state environmental protection administration of China (2002) and Yearbook of Miyun County (2007).

Table 2.10 Net load of water pollutants by different sources in the study area (2006)

Sources of pollutants	Frame	Unit	Net load of pollutants (t/year)		
			T-N	T-P	COD
1. Household					
Sewage plant	10,309	Person	10.95	1.64	54.75
Untreated waste water	118,343	Person	395.95	40.22	2,002.99
Total	128,652	Person	406.90	41.87	2,057.74
2. Non-point					
Upland cropping	36.864	km ²	30.59	1.20	55.30
Forest land	127.018	km ²	72.32	2.50	177.57
Orchard land	116.545	km ²	69.68	2.41	171.08
City area	96.437	km ²	84.48	6.34	538.55
Other land area	45.254	km ²	29.40	1.15	62.36
Total	422.119	km ²	286.48	13.60	1,004.85
3. Production					
Fisheries	4,230	10 ⁴ RMB Yuan	25.56	5.65	64.06
Pig farming	17,746	10 ⁴ RMB Yuan	901.18	355.15	5,544.80
Other stockbreeding industries	47,396	10 ⁴ RMB Yuan	758.04	229.77	2,291.31
Forestry	8,900	10 ⁴ RMB Yuan	100.27	3.61	226.37
Planting industry	7,564	10 ⁴ RMB Yuan	72.32	2.50	177.57
Manufacturing industry	265,297	10 ⁴ RMB Yuan	797.52	199.38	3,588.86
Other industries	76,275	10 ⁴ RMB Yuan	0	0	0
Total	427,408	10 ⁴ RMB Yuan	2,654.90	796.06	11,892.54
4. Rainfall			211.35	8.92	393.19
Total	188	km ²	211.35	8.92	393.19
Total			3,559.62	860.45	15,348.33

Source Miyun County Statistics (2007), pp 10–25

We used the data of 2006 for the study area. The basic data were obtained from the Yearbook of Miyun County (2007) and the digital data for the simulations were calculated based on this basic data and related statistics from the State Environmental Protection Administration (2002).

From the Table 2.10, we can conclude that the net load of waster pollutants by production occupied about 75 % of T-N, 92 % of T-P and 77 % of COD respectively. Therefore, the production has become the main water pollution source of the study area.

According to the results of statistics, stockbreeding wastes in the study area contribute heavily to water pollution, especially pig farming has become the source of the most serious pollution in the Miyun Reservoir. The net load of T-N, T-P and COD of pig farming industry accounted about 34, 45 and 47 % of the total net load of production respectively (Figs. 2.7, 2.8 and 2.9). In addition, with the implementation of “Strong Stockbreeding County” policy, it is can be expected that the pollutants emitted by pig farming wastes would dramatically increase in the future. Therefore, we should raise and carry out proper treatment method and

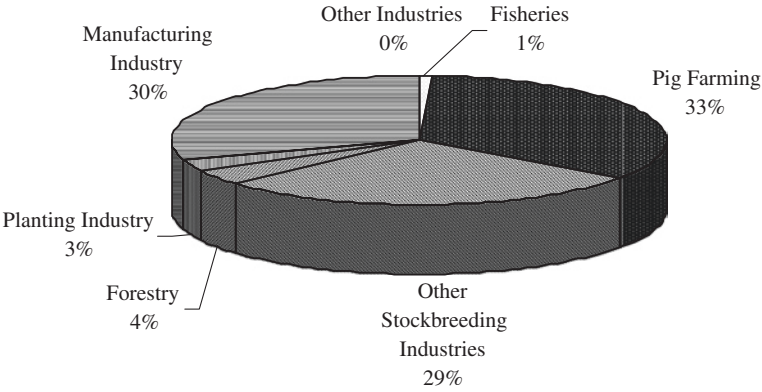


Fig. 2.7 Proportion of the net load of T-N in industry in the study area. *Source* Miyun County Statistics (2007), pp 19–20

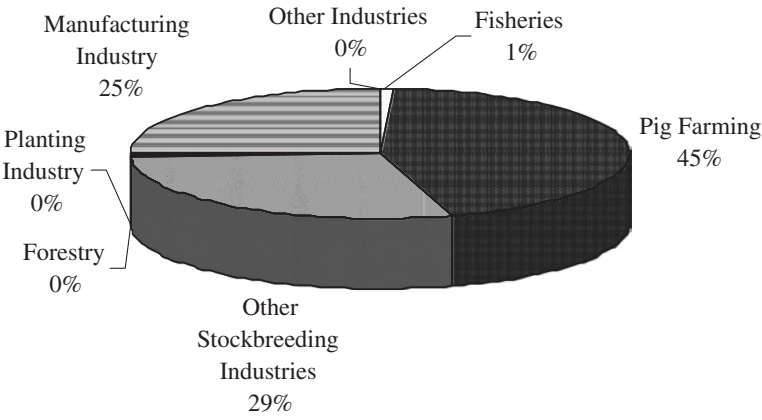


Fig. 2.8 Proportion of the net load of T-P in industry in the study area. *Source* Miyun County Statistics (2007), pp 19–20

integrated policies to realize the simultaneous pursuit of environmental preservation and economic development in the study area.

2.4 Implications and Conclusions

In this chapter, the characteristics of the Miyun County, Miyun Reservoir and the study area and the current environmental conditions are presented. In particular, this caused of water pollution are detailed. The main points conducted are: (1) stockbreeding industry specially pig farming industry concentrate in the catchment area of Miyun Reservoir causing considerable decline of water quality;

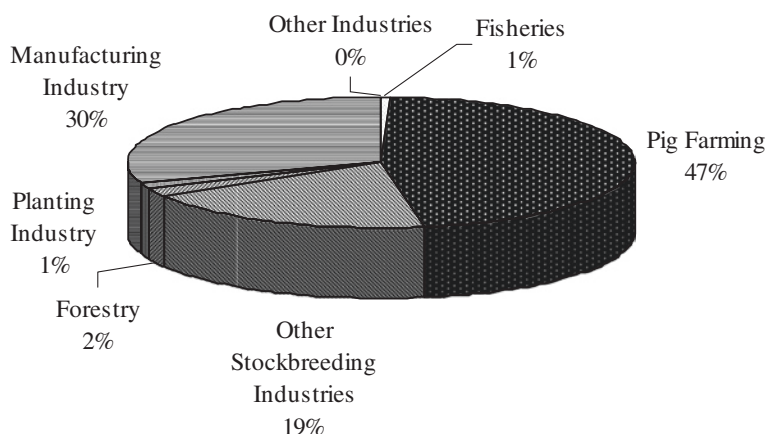


Fig. 2.9 Proportion of the net load of COD in industry in the study area. *Source* Miyun County Statistics (2007), pp 19–20

(2) stockbreeding wastes in the study area (upstream area of Miyun Reservoir in Miyun County) contribute heavily to water pollution, especially pig farming has become the source of the most serious pollution in the study area; (3) because of the requirements of water environmental protection in Miyun Reservoir, the regional economy slowly developed in the recent years in the study area; (4) Studies alert that, decreases in annual runoff to Miyun Reservoir are expected to significantly influence the regional environment, and the water quality of Miyun Reservoir worsen, leading to a serious water safety crisis for Beijing.

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