

## Effect and Measures of Soil and Water Loss on Water Quality of Dongping Lake

*Mao Weibing, Pang Qingjiang and Fu Liangshen*

College of Water Resources, Shandong Agricultural University, Tai'an, Shandong Province, 271000, PRC  
E-mail: flsh.62@163.com

**Abstract:** Dongping lake is a very important hydraulic junction of the eastern engineering of divert water from the south to the north. Water quality and ecological environment of Dongping lake will make important affection on this engineering. Soil and water loss is one of the some change of water quality of Dongping lake caused by soil and water loss is analyzed, and the measures of soil and water loss to effective control water pollution are discussed.

**Keywords:** soil and water conversation, water pollution, water quality of Dongping lake

### 1 The general situation of dongping lake

Dongping lake lies in the east of Dongping county, Shandong province and is located in north latitude  $35^{\circ} 30'$  —  $36^{\circ} 20'$ , east longitude  $116^{\circ} 00'$  —  $116^{\circ} 30'$ . It lies in the edge of the transition from the mountainous area to plain in the middle part of Shandong, facing the Yellow River on its northwest side, on the southwest of Pingyin, northwest of Wenshang, northeast of Liangshan. The whole area is  $627 \text{ km}^2$ . Dongping lake is the second largest lake with freshwater in Shandong province and is also a typical lake with freshwater in the east of our country, known as “the Small Dongting Lake” in Shandong.

Dongping lake is made up of the old lake (first class lake) and the new lake (second class lake). In the old lake area, ponding always occurs throughout the entire year. The basin of the lake is flat and its area is about  $209 \text{ km}^2$  with an average altitude of 38 m. The lowest altitude is 37.0 m. The meridional length of the old lake is 23 km, while the transmeridional width is 18.5 km and its corresponding sluice ability is  $1.2 \times 10^9 \text{ m}^3$ . The whole lake can hold  $4.0 \times 10^9$  cubic meters and it is a large reservoir to store floodwater in the Yellow River, and the likelihood is once every 60 years.

The new lake belongs to the drainage area of the Huaihe River and the old lake belongs to that of the Yellow River. Therefore, Dongping lake is the watershed of the two rivers.

#### 1.1 The hydrology condition of Dongping lake

The average precipitation amount per year is 624.4 mm in Dongping lake area. And because it is influenced by the monsoon, the seasonal variation of precipitation is very obvious. During the months from July to September, the precipitation amount is 74.4 percent of the annual rain capacity, and even during the months from July to August the amount is 52 percent. But in spring and winter the precipitation amount is only 6.3 percent.

The surface water of Dongping lake mainly comes from precipitation, water from the Yellow River which can be used, water from Wenhe River, and water impounded in Dongping lake. The present situation of water resources usage in Dongping lake can be seen from table 1.

**Table 1 The present situation of water resources usage  
in Dongping lake (unit  $10^4$  stere)**

Average water which can be used				Present situation of water usage			
Surface water	Foreign water	Ground water	Total amount	Surface water	Foreign water	Ground water	Average amount
10,948	5,490	18,495	34,933	413.8	5,490	16,459	22,362.8

## 1.2 Usage of land resources in Dongping lake area

Dongping lake lies in the bar billabong of alluvial plain where the Yellow River and Wenhe River anastomose in their lower reach. In the northeast of the lake area, hills are continuous and rolling, while in the southwest, it is plain with crisscross ditches and dykes.

According to local land general investigation, the soil fertility can be classified into five grades in the Dongping lake area. The first grade is the land with stable and high yield and it is mainly in the area of the east of the lake with brown aquipt soil, about 5.79 percent of the total tilled land. In the Dongping lake area, most of the land belongs to second or third grade, which is about 72 percent and most of this land is farmland with lower yield. The four and five grade land is mainly located in the hillock with sandy land, barren mountain ridge or waterlogged billabong and these two grades are about 21.8 percent of the total tilled land. The last two grades are not fit for agriculture usage because the soil fertilizer is very low and it is hard to be tilled, and also the irrigation and drainage condition is bad. The condition of the land fertility in Dongping lake area is listed in the following Table.

**Table 2 Statistics of each grade land in Dongping lake area**

Standard land grade	I	II	III	IV	V	Available land area	Total land area
Area (km <sup>2</sup> )	45.4	162.7	405	92.3	78.4	783.8	1,269.5
Percentage (%)	3.58	12.8	31.9	7.3	6.2	61.78	

Though multiplicate measures have been adapted to develop forestry during recent years in the Dongting lake area, the phenomenon of excessive land usage still exists frequently because of the stupid increased population. At the present time, the percentage of land usage in this area is 62 percent, and the tilled land is 56 percent of the total land area.

Most of the area in the new lake dries up throughout the entire year, because the main function of this area is to store floodwater in the Yellow River. Now except that there is still some stagnant water in the billabong of the district around the Anshan town with the lowest altitude, most of the rest are already reclaimed to cropland. People enclose lakes for cultivation blindly after 1963, which result in the misadjustment of the function of irrigation works, the decrease of the ability storing water, and eventually result in the increase of flood and waterlog. The land usage in Dongping lake area can be seen in Table 3.

**Table 3 Statistics of the land usage in Dongping lake area**

Item	Total land area	Tilled land	Woodland	Water area	Path and dyke	The rest	Uncultivated land
Amount							
Area(km <sup>2</sup> )	1,269.5	710.6	104.9	226.9	55.07	94	78.1
%	100	55.98	8.26	17.87	4.34	7.40	6.15

From Table 2 and Table 3, we can see that at the present time, the woodland area is only 8.26 percent of the total area in Dongping lake. 13.5 percent land suitable for wood has been cultivated to tilled land. Originally, Dongping lake area belongs to marsh, but because land is cultivated excessively and what's more, land is tilled in the hillside, soil and water loss is very terrible. The improper cultivation and usage has already destroyed the balance of the whole marsh environment heavily.

## 2 Condition of the water quality in Dongping lake area

The research indicates that the water quality of Dongping lake is mainly affected by the amount of pollutants in the lake. According to the statistics from 1990 to 1999, amount of the pollutants in the lake

increased constantly, and the water quality has the trend of deterioration year after year. Statistics of the mainly water quality index in Dongping lake is listed in Table 4.

**Table 4 Statistics of the mainly water quality index in each area of Dongping lake**

Lake area	COD <sub>xn</sub>	BOD <sub>5</sub>	DO	TN	TP	chl <sub>a</sub>
Tushan	5.98	2.49	8.10	2.68	0.065	0.0083
Sangyuan	4.89	2.47	8.65	2.95	0.044	0.0072
Daanshan	6.10	2.77	8.16	3.63	0.060	0.0052
Wangtai	12.57	6.03	7.04	4.66	0.138	0.0038
Wanglitun	5.56	2.02	8.58	2.99	0.042	0.0095
Chenshankou	5.56	2.99	8.62	3.15	0.045	0.0036

From Table 4, we can see that the areas that are polluted most heavily are Wangtai and Chenshankou. Wangtai lies in the entrance of the Dawenhe river mouth and the water area is small which result in that the pollutants cannot be diluted and degraded, so in Wangtai, the pollution is heavy. Chenshankou is located in the north of the lake, near the county seat, and the sewage of industry and agriculture nearby mostly drain to the lake, so the water quality is worse. The water quality of Tushan is best and it reaches grade two. Tushan lies in the center of the lake, its water bottom is flat and water surface is wide, so most of the water coming from places near the lake and the pollutant has been diluted and degraded before it enters the lake which makes the water quality of this area is best. The water quality of each area in Dongping lake can be seen in Table 5.

**Table 5 The water quality of each area in Dongping lake**

The subarea	Daanshan	Tushan	Sangyuan	Wangtai	Wanglitun	Chenshankou
The grade	III	II	IV	V	III	IV

### 3 The main affect of soil erosion in Dongping lake area

The area of tilled land in Dongping lake districts decreased constantly because of the rapid development of the population and economy and the increase of the area of various other land usage types. Phenomenon of destroying wood and enclosing lake for cultivation occurs sometimes, which eventually resulted in vegetation destroy and land bareness and aggravated the soil and water loss in this drainage area. The main affect of the soil erosion can be seen through the following four aspects.

#### 3.1 Aggravating water pollution in the lake and nutrition enrichment

Granules which enter Dongping lake mainly include organic matter, sand, clay and silt, most of which are washed out to the lake by rainfall in the drainage area. According to the statistics, because of the soil erosion, every year, the total amount of nitrogen that was input to the lake is 715 t/a, and for phosphorus, it is 31 t/a, all of which is 16 percent of the outside load of the pollutant in the whole lake. The large amount of nutriment such as nitrogen and phosphorus input to the lake is a main cause of the nutrition enrichment in Dongping lake. By analyzing the condition of the water quality and the index of every types, we can get the result of the synthesis evaluation of the degree of the nutrition enrichment in Dongping lake. It can be seen in the following table.

In addition, because large amount of mud and sand enter the Dongping lake, the diaphaneity of water and the validity of light was reduced and it also affected the growth of the aquicolous living things. For example, in the area of Wangtai and Chenshankou where water pollution is heavy, the content of the chlorophyll is obviously lower. (refer to Table 4)

**Table 6 Result of the synthesis evaluation of the degree of the nutrition enrichment**

**in each area of Dongping lake**

The subarea	Daanshan	Tushan	Sangyuan	Wangtai	Wanglitun	Chenshankou
The degree	Middle-rich	Middle	Middle-rich	Rich	Middle-rich	rich

### 3.2 The area of the lake is diminished gradually

According to the statistics of the dam in Dai village, the amount of sand that is transported to Dongping lake is  $4.9 \times 10^5 \text{ m}^3$  per year. What's more, as an important flood detention area of the Yellow River, every time when it stores the flood, about  $5.0 \times 10^6 \text{ m}^3$  sand will fill up the lake. The thickness is usually 0.5 m-1.0 m and in the thickest place, the thickness is 2 m. The affected area is about  $20 \text{ km}^2$ . The average depth of Dongping lake is 2 m—4 m, and every year, large amount of mud and sand enter it, which caused its west lakeshore line rising generally, so the old lake area has the trend of moving to southeast and shrinking.

### 3.3 It reduced the function of the lake

Because the lake has been filled up and the water level has ascended constantly, its ability of storing water decreased, which directly affected the function of controlling, storing and draining floodwater. So, flood and waterlog occurs frequently, which affected its further economy development at a large scale.

### 3.4 It has an ill influence on the environment of the lake area

Pollutants that enter and deposit in the lake, accelerate not only the lake shrinking, but also its contabescence process, which has resulted in deterioration of the environment.

In the research on aquicolous organism, it has been found that of the phytoplankton, green algae is most, which is 43.4 percent, and diatom is 23.3 percent, blue algae is 19.2 percent and the rest is only 14.1 percent of the total types. The number of the former fish types that were recorded is 55, but now it is only 30. Deterioration of the environment made the diversity of living things reduced, while excessive growth of the preponderant population resulted in further deterioration of the environment in turn.

## 4 Countermeasures of controlling the water pollution and soil erosion of Dongping lake

### 4.1 Restore the water plants and establish the semi-natural purifying marsh environment

Lake and marsh is the adjuster of the flux in the drainage area, and it is also the place where the “four water” is adjusted. Efficient filtration can degrade pollution and purify water. Marsh has many function such as adjusting the ecology and hydrology, controlling the environment.

Dongping lake belongs to area of marsh with fresh water, area in which ponding occurs almost throughout the entire year is  $167 \text{ km}^2$ . In recent years, the marsh in Dongping lake area has been exploited in a large area because the sharp increase of the population and economy. Now, most of the original marsh in Dongping lake has been developed to tilled land or land with other usage. From Table 3, we can see that the marsh area is very small. Marsh in Dongping lake area has been exploited and used excessively, which results in the lake area is smaller year by year and the function of marsh is retrograde heavily.

So, in order to change the present situation of the water pollution and soil and water loss, it is essential to establish and restore the original semi-natural mash ecological environment.

### 4.2 Pay attention to the construction of protection forest to hold soil and water

There are various types of relief in Dongping lake area, which provides a good condition to develop forestry. In some hills where the soil fertility is low and its cultivating quality is poor, people should reuse farmland for woodland. For the desolate sands area, shelter belt should be built to break wind and fix sand,

to avoid soil and water loss. Especially, in the hillock of its upper reaches catchment, water conservation forest and soil and water conservation forest should be strengthened to improve the land fraction of coverage, so that to reduce the rainfall's eroding power and the amount of sand entering the lake, to prevent the lake from shrinking and eventually improve the ecological environment in Dongping lake area.

#### **4.3 Restructure the industry structure and allocate the existing resources optimally**

To use the various resources such as water resources and land resources in the lake area, uniform layout and optimal allocation should be done. Research and carry out multiform production and management patterns of agriculture, forestry, animal husbandry, business, fishery and irrigation works as one suitable to local conditions.

#### **4.4 Protect forest resources rationally and control forest fall in the drainage area strictly**

The existing forest area is  $104.9 \text{ km}^2$  in Dongping lake area. The cumulation of timber at the end of the year is  $7.2 \times 10^5 \text{ m}^3$  and the annual fall is  $8.7 \times 10^3 \text{ m}^3$  (exclude the volume of local timber production). Considering the existing forest area and the present situation of the soil and water loss in Dongping lake, the existing forestry resources should be protected intensively and the forest fall should be controlled strictly so as to provide condition and guarantee to the continuable economy development in the lake area.

#### **Reference**

- [1] Gu Ding-xi, Shu Jin-hua. Forecast, Prevention and Cure of Water Pollution in Lakes[M]. Environment Science Book Concern of China, 1988.
- [2] Jin Xiang-can, Liu Shu-kun, etc. Lake Environment in China (the second volume) [M]. the Sea Book Concern, 1995.
- [3] He Chan-sheng. Management and Control of the Pollution in not point Places. Environment Science [M], 1998, **19** (5).
- [4] Oyang Qiu-lin. Research on the Effect of Soil and Water Loss to Water Quality of Qinglin Reservoir [J]. Journal of Conservation of Soil and Water, 1999, **19** (3).