J. of the Environmental Sciences
Vol. 12, No. 2, 139~144, 2003

Influence of the River Ceasing on Wetland Environment in the Yellow River Delta

Weifeng Chen, Yanxi Shi, Qinghua Mi and Seoung-Won Ann*

College of Resources and Environment, Shandong Agricultural University, Taian 271018, China
**College of Industrial Science, Kongju National University, Chungnam 340-802, Korea*

(Manuscript received 5 December, 2002 ; accepted 24 January, 2003)

The Yellow River began ceasing affected by natural factors and the unreasonable human activities. The flow broke in the Yellow River and water and sediment flowing into the sea decreased, which lowered the speed of newly formed wetland extending to the sea. The water environment deteriorated; Its composing structure tended to be unsteady; The biologic diversity decreased and wetland function reduced. To ensure that the Yellow River delta and its ecosystem develops sustainablly, it is significant to reduce times and days of the ceasing, keep certain runoff and sediments in the river to the sea and make its watercourse stable.

Key words : Flow breaking, Yellow River, River ceasing, Delta environment, Wetland; Biodiversity

1. Introduction

Wetland of the Yellow River delta is the most integrate, widest and youngest newly formed wetland ecosystem on the sea in warm temperate zone of our country. It is an area with plenty of wetland types and is one of the areas with most abundant biologic diversity in the world, which is representative in the newly formed wetlands at the river mouth on the sea in china and even in the world. It is an important base where research can be carried out to study the mechanism in which wetland formed and grew, succession of the river mouth ecosystem and influence and response of the world climate change to the wetland. And it is also an important place to research how to protect the species and make them migrate successively. Now the Yellow River delta has become a wetland-protection area in our country, and project of Sustainable development of the wetland and its ecosystem in the Yellow River delta has been listed on the prior action plan. The Yellow River continuously washed out, silted the land and changed its way, creating this open newly formed wetland together with the water driving of Bo Sea for hundreds of years. But in the recent 30 years, especially since the 1990s, the Yellow River ceased frequently because of the comprehensive effect of the many kinds of natural and human factors. And at the same time, amount of water and sediments flowing into the sea per year kept a low level. As far as the Yellow River delta, the rivers frequency ceasing has restricted peoples living and production in industry and agriculture, and also has harmful effect on the deltas environment, thoroughly studying of which will have significant sense to guarantee its sustainable development.

Corresponding Author ; Seoung-won Ann, College of Industrial Science, Kongju National Univ., Chung-nam 340-802, Korea
Phone : +82-41-330-1224
E-mail : annsw@kongju.ac.kr

2. Flow breaking in the lower reaches of the Yellow River and the reasons

As far as the contemporary Yellow River delta, Lijin hydrologic station situated where the Yellow River flowing into the sea is considered having authority most. According to this station, the Yellow River first ceased in 1972 and till 1990, there are not many years

and days in which ceasing happened. But since the 1990s, ceasing happened almost every year and the first ceasing time moved forward with longer time and farther distance. In 1997, ceasing time has reached 226 days, after then, it decreased gradually. From March 1999, The Yellow River water conservancy commission regulated and distributed water in the entire drainage area and until now, the Yellow River has not dried up for three successive years (Fig. 1).

Ceasing in lower reaches of the Yellow River is the direct reflection of the unbalance of water supply and demand and the decreasing adjusting function of the entire river basin. It is also the outcome of comprehensive effect of natural and human factors. In recent years, the entire domain of the Yellow River maintained dry, and the rainfall is scarce, thus the Yellow River water decreased, which is the natural backdrop and important reason of the ceasing, but is not the fundamental reason. From 1855 Tongwaxiang burst and taking Daqing water-course to 1971, it had not ever ceased. So, more experts are inclined to consider that it is the human reasons that resulted in ceasing of the Yellow River[1]. The Yellow River drainage area is originally lack of water, and both the amount of water possessed by person and area is lower than the averagely level all over the country. The water-saving project developed well with policy backing and capital devoted and water-used rate increased gradually, but because of the fast development of agriculture and industry and the contorted water price system, the aggregate demand of water has increased instead of decreased and it has greatly exceeded the capability of the Yellow River. Besides, the demand of water is not always correspond to its space distribute, whats more there is not unite management of water. Ultimately, water used in the lower reaches exceeded the coming from the upper, thus, flow breaking happened. From 1999, the Yellow River didn't ceased, which is because of unite distribute of water and is the result of administration and economy means. It is well, but is not very much optimistic, because the means of reducing water used in the upper and middle reaches is not the ultimate solution to solve the water scarcity of the whole drainage area.

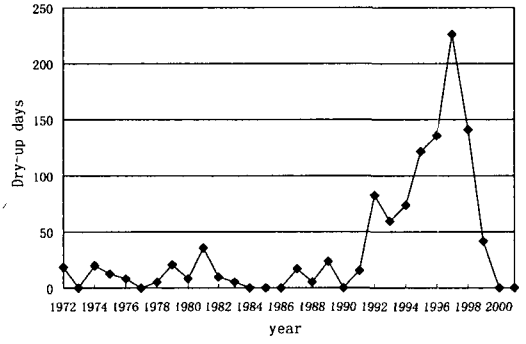

Fig. 1. Ceasing days in the Lijin station of the Yellow River.

3. Effect of the Yellow River ceasing on wetland environment

3.1 Effect on the wetland water environment

According to the history data in Lijin hydrologic station, before 1970, the amount of water in the river was relatively steady, all of which is more than 400×10^8 m^3 per year; but after ceasing happened, from 1970 to 1997, it was only 252×10^8 m^3 per year, and the trend was that the amount was decreasing year by year (Table 1).

The replenishment head water of the original wetland far from the Yellow River and seacoast is rainfall to maintain water environment balanced, but for the open original wetland such as wetland on beaches and meadow effected by salt on the sea, the head water is tidewater influenced by the water level and the flooding

Table 1. Average runoff and sediments into the sea in different age of Lijin Station[2]

year	Average runoff $\times10^8$ m^3	Average sediments $\times10^8$ t	year	Average runoff $\times10^8$ m^3	Average sediments $\times10^8$ t
1855-1859	560	15.9	1920-1929	416	10.2
1860-1869	568	16.2	1930-1939	499	14.5
1870-1879	574	16.4	1940-1949	560	13.0
1880-1889	567	16.2	1950-1959	464	13.2
1890-1899	570	16.2	1960-1969	513	11.0
1900-1909	554	15.7	1970-1979	304	8.9
1890-1899	570	16.2	1980-1988	292	6.5
1900-1909	554	15.7	1989-1997	159	4.36
1910-1919	539	15.1			

area, so, it is not effected much by the Yellow River ceasing. But there is still large area of the original wetland that is directly affected by the river ceasing. For example, the Yellow river itself is the largest fluvial wetland in this area, but during the period of the flow breaking, the water in the river course disappears; Water level descends; The climate becomes dry and the river even changes to a sand belt. The rivers breaking and runoff reducing affected water quality in the shallow sea, making water temperature reducing, salinity ascending, and content of nutrition decreasing[3]. In recent years, it is more and more serious that many pollutants were drained to the Yellow River and the rivers ceasing didn't stop this. The pollutants were piled up in the watercourse, making the its bottom and soil polluted. When the river flew again, water flowing into the Yellow River delta sometimes was polluted seriously, even brought about paroxysmal water polluted accidents in the lower river course and areas near the sea. Besides, wetlands along the Yellow River can be irrigated by water with sediments and lower salinity, maintaining higher water level, and without this, the water level will decrease and the water quality will deteriorate, thus making the vegetation develop conversely. Effect of the Yellow River ceasing on water environment of the artificial wetland is more obvious. For example, the rivers ceasing and having no sufficient water will make the water level of reservoirs, ponds, ditches and all kinds of fresh water reduce and even dry up, and farther more affect its ecosystem.

3.2 Effect of the Yellow River ceasing on wetland forming

The Yellow River delta is a newly formed land when the Yellow River silted, swayed, changed its course, so in the area where the Yellow River enters the sea, it is silting ahead. The seacoast of the Yellow River delta is chiefly made up of silty soil and is not steady in sediment structure and physiognomy developments. Whether it is developing depends on the coming silt amount. Once it decreases, the coast wetland is prone to be eroded. So, there were both sediment and erosion during the coarse of wetland formed. The ratio of silting ahead to eroding behind mainly depends on the amount of sands to the sea and the oceans driving forces.

From table 1, it can be seen that ever since the 1970s when the Yellow River began ceasing, the runoff entering the sea had decreased. Although the Yellow River delta is still extending to the sea as a whole, the speed of it has the trend of decreasing gradually. From 1976 to 1986, the average area that extended to the sea was 37.65 km^2 per year, and from 1992 to 1996, it was merely 13 km^2 per year. Even from October 1997 to October 1998, the increasing area is only 10.98 km^2; Further research shows that the area that extended to the sea has positive correlativity with the amount of silt coming, and when it is 2.45 million tons, the Yellow River delta tends to be in equilibrium state[4]. So, the flow breaking in the Yellow River has great effect on the area of newly formed wetlands. If this phenomenon continues, and the silt entering the sea decreased continuously, together with the effect of sea level ascending and ground subsiding, the speed of the coast being eroded back will fasten. Hence, the Yellow Rivers long-time ceasing will not only lower the speed of the wetland forming, but also make the Yellow River delta become an area where newly formed wetland is eroded back with fastest speed.

3.3 Effect on wetland types and composing structure

The Yellow River delta has plenty of wetland types including natural wetlands such as shallow sea, sands, grass marshland effected by salt, shrubbery and artificial wetlands such as rice paddy, saline, shrimp and crab pools, reservoirs, ponds, ditches. Influenced by many kinds of natural and human factors, the types and composing structure of the wetlands in this area is complex. From the 1980s, types and the composing structure were not steady, with the Yellow River ceasing more seriously. Fig. 2 illustrates the changes of several wetland types in different years. The reed is a widespread breed in this area, and the key factor to restrict its distribution is water content of the soil. Area of the natural and artificial reed shrank gradually because the frequency of the floods decreased and irrigating water was

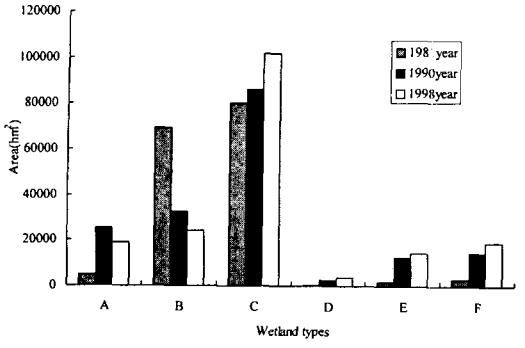

Fig. 2. Changes wetlands of sever types in the Yellow River Delta[5].
A: Paddy fields B: Reed bed
C: beach D: Salt pond
E: Reservoir F: Pond

lacking; The frequent ceasing of the Yellow River has improved peoples consciousness to store water, so, areas of artificial wetlands such as reservoirs and ponds increased gradually; Rice is a crop which costs a great deal of water and its transplanting time is exactly the time when the Yellow River ceases. So, people have to adjust their planting structure, which made the area of paddy fields changing from increasing to decreasing. It can be predicted that as the Yellow River ceases and wetland continues being exploited, the trend that natural wetland increases might be changed, which will make the total areas of the natural wetland resources decreasing and that of artificial wetland increasing. Consequently, the composing structure of the wetland in this area will tend to be more complex and unsteady.

3.4 Effect on biologic diversity

Wetland in this area is a typical wetland ecosystem forming at places where the river flows into the sea, and is one of the areas with most plenty of biologic diversity. It was created and affected by water and sediment in the Yellow River together with the driving forces of the ocean. So, long time ceasing of the river and decrease of water and sediment will affect the distributing pattern of wetlands in this area affected by both fresh water and the sea and change the ecologic living conditions of the species, which will decrease the biologic diversity.

Theres obvious effect of the Yellow River ceasing and decreasing water into the sea on biologic diversity of the ocean fishes. Long time ceasing changes the route of fishes migration in both oceans and rivers, which makes biologic chain break; The decreasing runoff to the sea will make the water temperature falling, salinity increasing and nutriment reducing, which affect the productivity of the shallow sea wetland and will do harm to the living beings. According to statistics, since the Yellow River dried up, the reduced inorganic nitrogen is averagely 2,535 t per yea, and the reduced phosphate is 44 t per yea. The production (pure weight) of phytoplankton reduced by about 500 thousand[5]. In the season of from April to June when fishes and shrimp spawn, the flow breaking will make types and number of spawn and young fish reducing and the fishery resources decreasing, which further make the whole fish ecology composition changing and its diversity reducing. And when the river flows again, the outburst pollution in the shallow sea will also affect the biologic diversity. Considering food chain, the reduction of productivity and diversity of the ocean living beings and fishes will also affect the diversity and distribution of birds in this area.

Because of the reduction of flooding and irrigating, much natural wetland tends to dry; the soil salinity aggravates; the swampy plant degenerates and plants bearing salt increases, all of which accelerate the replacing course of from swampy plant to saline plants and make plant diversity decreasing and inherit gene die out. There is near 200 thousand hm^2 water area in the Yellow River delta now, and on the grounds of primary statistics, there are 456 kinds of water living beings. But the Yellow Rivers long time ceasing makes most water area dry, which endangers the water living beings and results in degeneration of the ecosystem and reduction of its diversity.

3.5 Effect on the wetland function

There are ample resources such as oil and natural gas in the Yellow River delta and it is the second oil field in china. And it is also an important production base of grain, cotton, livestock and aquatic product. So, the most

contribute it does to mankind is its production. But whether agriculture and industry goes on successively and can realize sustainable development has close relation with the supply of water in the Yellow River.

It has been mentioned that the nutriment decreased near the sea because of the Yellow River ceasing, which effected the productivity of fishes, and even resulted in many migrating fishes dying out; The pollution brought about by the river ceasing also affects the fishery production. Besides, as the biggest river wetland and the main foreign fountain in this area, the Yellow River delta is the only water sources of the most engineering of impounding water. Flow breaking in the Yellow River made the amount of water supply decrease and also reduced the capacity of the artificial wetland such as reservoirs, which held back the development of industry and agriculture. Long time ceasing of the Yellow River limited the amount of water the oil field used. When seriously lacking of water, seawater and polluted water has to be used which reduces the output and quality of the oil; Fresh water breeding industry is flourish, and in 1994, the breeding area reached 1.28×10^4 hm^2 with more than 20 types. But as a result of the Yellow Rivers long time ceasing, season and area when and where breeding can develop was affected greatly and the yield reduced by 20 percent[6], and restricted the exploitation and development of the freshwater breeding; Because of being short of irrigating sources, many reed swamp degraded to reed meadow and the former productivity is 2.4 to 8 times of that of the later[5]; Paddy is one of the means of this area to improve saline soil productivity and the Yellow River is its only irrigating water. In spring, the flow breaking restricts the seeding and in 1997, the long time ceasing destroyed the paddy production enormously.

4. Discussion

Ceasing of the Yellow River is caused by that water is used too much in the middle and upper reaches and there is not corresponding regulating project and management so that there is too little water flowing to the lower reaches. It is the comprehensive results of natural and human factors. Practice has proved that distributing water in the entire river basin of the Yellow River can maintain the river flowing on, but it is not the ultimate solution. Project of drawing water from the south to north is an important way to solve this problem, so, putting the project into practice is very important to stop the Yellow River ceasing.

Fresh water flowing into the wetland reduced because of the Yellow River ceasing and the water environment deteriorated. The natural quality of the wetland decreased and composing structure became unsteady which restricted the wetland developing positively; Whats more, with the flow breaking time prolongs and the sediments decreasing, silting and eroding may tend to come to equilibrate and until distance of eroding back is more than that of silting ahead and the newly formed wetland decreases; Deterioration of the environment made the wetland biologic diversity and the productivity of living beings especially of fishes decreasing; The river ceasing also restricted water supplying and regulating capacity of rivers, reservoirs and ponds, and it influence regular production of industry and agriculture. The productivity of wetlands decreased.

In recent years, although flow breaking of the Yellow River has been controlled through unitary regulation of the whole river basin. But threaten has not been ultimately eliminated. At present, researches on the effect of ceasing and changing its course of the Yellow River on the wetland environment are mainly through qualitative analysis and ration research is fewer. Lucubrating on the threshold of water demanding of wetland, researching and evaluating the effect of Yellow River ceasing and changing its way on wetland environment rationally, setting up mathematical model, analyzing its tendency and bringing forward warning and corresponding scientific countermeasures as soon as possible is significant to the sustainable development of wetland and its ecosystem in the Yellow River delta.

Acknowledgments

This work was founded by grants from College of Industrial Science Kongju National University and the Natural Science Foundation

of Shandong Province, PR China. The authors wish to thank to Kim Seong-min etc. of the College of Industrial Science Kongju National University, for their assistance during the course of protection and research of wetlands in Shandong Province.

References

1) Geoscience department of Chinese Academy of Sciences, 1999, The countermeasure and advice about ameliorating the Yellow River, Advance in Earth Sciences, 14(1), 1-3.
2) Wu, S. Y., X. F. Shi, and Y. G. Liu, 2000, Influence of The Yellow River Zero Flow on Delta Petroleum and Gas Exploitation Environment, Engineering of Seaboard, 19(4), 33-40.
3) Tian, J. Y. and M. Wang, 1997, Study on the affect of the drying up of the Yellow River on the ecological environment in the seawater near the delta, Marine Environmental Science, 16(3), 59-65.
4) Li, X. N., S. G. Liu, and C. X. Li, 2001, Analysis of Critical Value of Inflow Sediment for Keeping Erosion and Sedimentation Balance in the Yellow River Delta, Yellow River, 23(3), 20-21.
5) Liu, H. Y., X. G. Lu, and Z. Q. Liu, 2001, Deltaic Wetlands in Bohai Sea: resource and development, Journal of Natural Resources, 16(2), 101-106.
6) Tian, J. Y., M. Wang, and H. Y. Dou, 1997, Influence of flow breaking in the Yellow River on the environment of its delta and countermeasures. In: Department of Nature Reservation of National Environment Reservation Bureaued. Flow breaking in the Yellow River and sustainable development of its basin, Beijing, China Environment Science Press, 19-22pp.