

Degradation problems of the land/water ecotones in China and their ecological impact to water systems*

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Abstract—Degradation of land/water ecotones in China is a serious problem and it is often neglected by people. The types of ecotone degradation are described and analyzed. The degradation of land/water ecotones enhanced the water quality reduction, bank erosion, disasters such as landslide, flood and drought, biodiversity reduction, lost of fertilized lands, decrease of the resource value of water scenic beauty and many others. The paper analyzes how these problems are related with each other.

Keywords: land/water ecotones, degradation, types, impact on other systems.

In China, there has been a rapid economic development in the past twenty years. But it depends mostly on a great input of investment and high exploitation of the natural resources. As the result, many ecological problems occur in the territory of China (Yang, 1998). The water problem is one of the most serious. In 1997, the Yellow River, the second largest river in China, stopped flow in downstream for 224 days, shown as the longest historical record. In 1998, the most serious flood level happened in the Yangtze River, and there was the largest red tide in Bohai Sea with an area over 3000 km². All these record broken events indicated that the ecological degradation in China's environment is growing serious and it threatens the state safety and further development of our country. The big flood in 1998 makes more and more Chinese people realize the danger of the ecological degradation.

Among the many environmental problems, the degradation of land/water ecotones in China is also serious and has been neglected for a long time. Land/water ecotones are the transition zones between the terrestrial and aquatic ecosystems (Naiman, 1989). In recent years, the scientists have found that they play important roles in the riparian water quality and landscape ecological stability (Mitsch, 1991, Hillbricht-Ilkowska, 1993). Land/water ecotones can be divided into the following types: head water ecotones, river-side ecotones, lake-side ecotones and surface water/groundwater ecotones (Fig. 1; Yin, 1995). It is found that the four types all have the degradation problems and the vegetation cover along the water-sides is poor in most areas. In this article, we would show their degradation in an view of landscape ecology and analyze its impact on China waters.

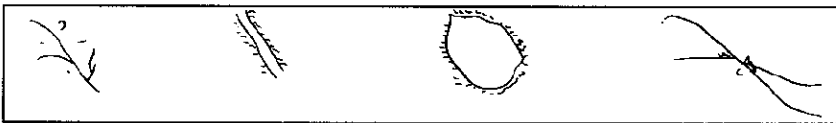


Fig. 1 Four types of land/water ecotones

1 Degradation of head water ecotones

Deforestation and overgraze on grassland have a great impact on the headwater ecotones. These

* Sponsored by the Chinese Academy of Sciences as the grant KZ951-B1-208

actions happen in nearly all the provinces and they are more serious in the western provinces. The mature forests are the most protector for the river sources. The recent investigation indicated that the mature forest's area is 8.49 million hectares, only 38% of that in 1980. The other landscape patches are also in degradation. In the source region of the Yangtze River, the total 627 glaciers are mostly on a shrivel states. The lakes in that region suffer from area reduction, internal flowization and salinization. Some small lake have disappeared permanently. Many swamps have become grassland. Desertification are very active (Sun, 1995). In China, the degraded grassland has occupied one third of the total grassland with an area of 870000 km² because of over-grazing and changing into farmland as the results, the declined vegetation in the forest and grassland makes the water penetration more difficult and most water flows into runoff during and after rains. There are high runoff peak levels, and in many cases, floods after storms. The base flows and springs become much smaller. Without the protection of a good vegetation, the soil erosion is more serious and the small ditches of the headwater ecotones are eroded to become large and deep ones.

Tuotuo River is the headstream of the Yangtze River. There are 4678 km² of bare land without any vegetation in its 10217 km² catchment and 1942 km² of land has turned into desert. In Qinghai Province, there is water erosion area with an area of 750000 km² in the Yellow River's source region, where, forest coverage is only 0.35%. Because the vegetation degradation, soil's water retention ability declined dramatically. Inflow water decreased by 22.7% during the period from 1990 to 1996, compared with the average level during 1950 to 1989.

Degradation of headwater ecotones also happen in agriculture regions. One example is the destruction of multi-pond systems. The multipond system is a typical subtropic landscape and is a part of ancient Chinese culture. Such system used to exist in large areas in Southern and Eastern China. The results of scientific research shows that the multipond system can retain water, nutrients and sediments, and it is a good method for sustainable development in China (Yin, 1993). But in recent 20 years they were destroyed in many regions because the modern reservoirs and channels were constructed for irrigation. Many of the ponds were turned into farm land or used for house construction. It is estimated that the pond area is decreased by 50% in recent 10 years and the multipond system will disappear in about 20 years. Because of this, the water holding capacity of the watershed is greatly reduced and the danger of flood and drought is increased.

2 Bank erosion and bank collapse in degraded river-side ecotones

Along many rivers in China, it is found that there is poor vegetation along the river-sides, in comparison with other major rivers in the world. Because of this, bank erosion can be observed in most rivers and it has become an important source for the sediments into the river and accumulated on the river beds. In some cases, the degradation of river-side ecotones causes large scale landslides and bank collapse. These disasters mostly happen in upstreams of the Yangtze River and other rivers in the West China, where storms are frequent and mountain land vegetation are damaged seriously. It was investigated that from 1981 to 1990, there are 7473 events of medium and large-scale landslides, bank collapse and mud-rock flow disasters at the cost level above 100000 RMB Yuan in China (National Research Group Against Big Natural Disasters, 1992). On July 18, 1982, a large landslide happened in Yunyang County at Three Gorges of the Yangtze River. A big village with 1730 houses was destroyed and the huge landslide blocked the Yangtze River channel flow. In February of 1998, there happened 150 km of bank collapse along the Yangtze River middle branches in Hubei Province.

3 Reversed ecotones caused by the high river bed

The natural rivers are drainage channels of runoff water and the water level is usually lower than the adjacent land. But because of erosion in the watershed and the sediment fill up, the river bed is high in many branches and that causes the water level even higher than the adjacent land. Such ecotones have lost most natural functions. Downstream of the Yellow River has been higher than the lands for several centuries and been called "xuan he (hanging river)". Now more and more rivers have become hanging rivers. The Jingjiang Branch of the Yangtze River is a hanging river and Dongting Lake is a hanging lake. Such waters have to be protected all the year with dykes and they are dangerous during the flood time.

4 Disappearing ecotones by the dry river beds

Because dry weather and over utilization of upstream water resource, many rivers in North and Northwest China have become seasonal rivers. In more than half of the year, there is no flow and the bare river bed is exposed to the atmosphere. Because of no water, many of the ecotone plants and animals have died or degraded. Many rivers only received wastewater in dry seasons and contaminants are accumulated on these dry river beds. In the raining seasons, the flow starts again and the contaminant concentration is very high in the first a few days of the flow. It is observed that in the dry the Yellow River the ecotones are unstable and the sediments begin to move from the river-side to the central channel by the force of wind. Such movement is against the nature and might cause flow resistance and flood danger in the future.

5 Channelization of river banks makes the ecotone unsuitable for life of organisms

In the eastern part of China, most river banks are channelized. The original natural ecotones, which show a gradual distribution change from terrestrial to aquatic vegetation, have been replaced by simple stone or cement dykes. In some other places, the natural meandering streams are changed into straight channels in order to make more land for people. These dykes are hard, resistant to bank erosion and safe for flood control. However, such channelized ecotones are no longer good habitats of diversified biota and their other ecological functions are also reduced.

6 Disappearance of river-connected wetlands and reduction of water holding capacity

Wetlands along the major rivers were damaged seriously. Many wetlands were turned into farmlands and those which remain natural have lots of smaller areas. Along the Yangtze River, there used to be 22 large lakes and wetlands directly connected to the river and they had a total area of 17000 km² and water holding capacity of 120 billion m³. Now their area has reduced 6700 km² and holding capacity reduced 120 billion m³. The disappearance of river-side wetlands reduces the buffering capacity and enhances the danger of flood disasters.

7 Pollution in river-side ecotones

It is found that many river banks are seriously polluted in China. In upstream of the Yangtze River, many river-side lands become garbage dump sites and some local people let the flow to wash away the garbage during the high-water season. The garbage is carried thousand kilometers away to the downstream and sometime blocks the Gezhouba Hydropower Plant to make a big economic loss. The garbage polluted the water and also tourism sight and it becomes a problem more and more seriously.

8 Degradation of lake-side ecotones by lake area reduction

According to investigations, the total lake area in 1977 was 80645 km² and in 1985 it was 71787 km². The lake depth also reduced. Qinghai Lake, the largest lake in China, has a continuous water level decline of 3.0 meter in recent 30 years, 0.102m each year. It causes a large scale change of the lake-side ecotones. The vegetation cannot catch up with the rapid movement of ecotones. It is not stabilized and many plants die.

In recent 40 years, there have been several large scale movements to "reclaim lands from lakes" and millions of people participated in. Such actions produced large areas of farm lands around Dongting Lake, Boyang Lake, Dianchi Lake, and many others at the cost of lake areas reduction.

9 Littoral zone degradation, disappearance of macrophyte and enhanced symptoms of eutrophication

In the eastern part of China, the most natural lakes are in states of eutrophication. Many lakes have massive macrophytes and these plants reduce the symptoms of eutrophication. But the destruction of the lake shore macrophytes by unproper management enhanced the algae bloom symptoms. Chaohu Lake is one of such lakes. Before 1960, 15% the lake surface areas were covered by macrophytes and the eutrophication symptoms are not evident. In 1959, two large water gates were constructed in down-stream and the lake water level began to be completely controlled by human-being. Too high winter and spring water level killed the lake shore macrophyte and the algae bloom becomes more and more serious.

10 Bank erosion and sediment resuspension in lake-side ecotones

The degradation of lake-side ecotones makes bank erosion and some times bank collapse. In China, the reservoir construction projects do not include reservoir bank stabilization measures. The new formed land/water ecotones have to undergo long term process of erosion/revegetation before their final stabilization. Many reservoirs do not control water level according to the need of ecotone stabilization and the annual change of water level is very large. As the result, the most reservoirs in China have bank erosion problems. In Sanmenxia Reservoir on the Yellow River, the bank collapses exist for 74 km with a depth of more than 30 meters each year. Thousands of hectare lands are destroyed and tens of millions tons of farmlands soil were washed into the water. To treat the bank erosion, the reservoir administration decides to build a cement bank and that will destroy the ecological functions of the reservoir bank.

11 Reduction of self-purification functions to cause more serious water pollution

The healthy ecotone area has strong purification ability due to the diversified fauna and a variety of physiochemical micro-environment. It can retain and transform organic matters and other contaminants flowing through it with water. By this way the water quality is protected. Ecotone is therefore the buffer zone between terrestrial and aquatic ecosystem. The degradation of waterside ecotones makes the water system expose to the direct input of terrestrial pollutants and excessive nutrients, such as nitrogen and phosphorus. It enhanced water pollution and eutrophication in China.

12 Over immigration of human being to the water-side lands

With the quick expanding population in affluent floodplain areas, waterside ecotone areas have been replaced by more and more cultivated land and constructed land. There are more than 500000 people living around the Dongting Lake, most of them are engaged in crop and reed production in

the ecotone areas. Some people live in the highlands (“wei yuan”) built in the river, which are surrounded by dykes. In 1998, nearly 21 million people in the area were hit by the unprecedented flood and 609 people died. Human’s activities disturb ordinary cycling of water and other materials in ecotone. At the same time, all development and progress are facing an increasing threat of natural disaster.

13 Reduction of biodiversity with degraded ecotones

As discovered by many scientists, wetlands are the habitats of many plant and animal species. The degradation of ecotones reduced the biodiversity and it would influence a large scale biological distribution. In Honghu Lake, after some littoral zones were changed into farmland, the number of organisms greatly reduced. From 1950’s to 1980’s, macrophytes species numbers reduced from 92 to 68, the fish species numbers reduced from nearly 90 to 31. The fish production is reduced up to 40%. Similar phenomena happen in many other waters.

As stated above, the degradation of land/water ecotones is becoming more serious in China. This has produced great impact on the adjacent water and land. It enhanced the following problems: the water quality reduction and eutrophication, bank erosion and bank sediment resuspension, disasters as landslide, flood and drought, biodiversity reduction, interference in aquatic productivity, lost of fertilized lands, decrease of the resource value of water scenic beauty and many others. It should be emphasized that ecosystems are interrelated together and ecotones are the connection. Land/water ecotones are more difficult to restore because they lie in between two ecosystems and more easily effected by either of the system. Land/water ecotones are treasurable resources of the nature and should be carefully protected. The degradation of the land/water ecotones should draw greater attention of the scientists as well as the decision makers so that they would be better protected.

References

- Hillbricht-Ilkowska A, 1993. *Hydrobiologia*, 251: 257—268
- Huang W, Wu T, Shu J, 1998. *Journal of Lake Sciences (in Chinese)*, 10(3): 83—89
- Ministry of Forestry Department of Wildlife and Forest Plant Protection, 1996. *Wetland protection and rational utilization*. Beijing: China Forestry press
- Mitsch W J, Reeder B C, 1991. *Ecological Modelling*, 54:151—187
- Naiman R J, Decamps H, Fournier F, 1989. The role of land/inland water ecotones in landscape management and restoration. *MAB digest 4*, UNESCO, Paris
- National Research Group Against Big Natural Disasters, 1992. *The big natural disasters in China and their countermeasures*. Beijing: Science Press
- Sun G Y, Tang B X, 1995. A study on natural environment of source region of the Changjiang River (Yangtze R.). Beijing: Science Press. 133—134
- Yang C, 1998. *China Environmental Management*, 93(1):7—10
- Yin C Q, 1995. *Acta Ecologica Sinca*, 15(3):331—335
- Yin C Q, Zhao M, Jin W G, Lau Z W, 1993. *Hydrobiologia*, 251:321—329