High Population Beaches Land safety Use Planning of the Yellow River lower reaches Under the Conditions of Artificial Flood Control

Bin LI, MING-ZHOU QIN, Peng-yan ZHANG; China

Keywords: Geoinformation/GI; Land management; Land readjustment; Remote sensing; Risk management; Security of tenure; Spatial planning

SUMMARY

With the largest population and fast development, China is facing seriousness situation of land resources now. The lower reach of yellow River, located in the center of Chinese food production base, is not only the most important water supply for the large region including agriculture, industry and resident's living, but also dominates the surface complexity proceeding in this area. The unique suspended river course and large beach in the world are formed here. Especially, there are many people and residential sites including small city, town, village building up within the suspended river beach, which are facing directly the complicated safety stress. In this article, Yellow River beach land in the Kaifeng area is used as a case study to explore beach utilization issues after Xiaolangdi Reservoir (Dam) flood control. Based on the latest SPOT2.5 images for 2007 and other typical Landsat TM data(1992-2007), using ArcGIS and ERDAS, along with field surveying and investigation; various high level floods with flows over 4000m3/s are simulated and the potential submerged areas within Kaifeng Yellow River beach region are identified. Finally, in the light of the research outcome, together with the incorporation of new socialism village construction standards, four zones of ecological protection and safety use to avoid floods are suggested for the Kaifeng Yellow River beach region. At the same time, some important measures are proposed for using beach land resources and ecological safe respectively while avoiding flood risk.

SUMMARY

由于巨量的大国人口和快速发展，中国正面临严峻的土地资源局势。黄河下游位居中国粮食主产区的中心，不仅为广大地区的城市、工业和居民提供了最重要的水源，而且也主导了当地的地表地理过程。下游河道高出两岸地面，河道内滩区宽阔形成了世界上独特的"悬河"景观。特别是，分布在滩区的大量人口和居民点，如小城市、镇、村落等，直接面临复杂的安全胁迫。本文以开封市黄河滩区为例，探索了在小浪底水库洪水控制运行条件下的土地合理利用问题。首先是基于 2007 年的 SPOT2.5 和其他陆地卫星 TM 数据，利用 ArcGIS 和 ERDAS，结合野外调查测量，分析预测了本地 4000 m3/s 以上常遇洪水的淹没区。然后，根据分析结果，提出了 4 个土地生态保护与避洪安全利用带，提出了不同地带的利用措施。

High Population Beaches Land safety Use Planning of the Yellow River lower reaches Under the Conditions of Artificial Flood Control

Bin LI, MING-ZHOU QIN, Peng-yan ZHANG; China

1 INTRODUCTION

With the largest population and fast development, China is facing seriousness situation of land resources. The lower reach of Yellow River, located in the center of Chinese food production base, is not only the most important water supply for the large region including agriculture, industry and resident's living, but also dominates the surface complexity proceeding in this area. The unique suspended river course and large beach in the world are formed here. Especially, there are many people and residential sites including small city, town, and village building up within the suspended river beach, which are facing directly the complicated safety stress. The latest statistics （2009）show that there were 1.8 million permanent residents and 0.24×10^6 hm2 of cropland in the lower beaches, belonging to 1,819 villages, 43 counties, 15 cities, and the two provinces of Henan and Shandong. The population density is about 510 people per km^2 as four times of average density of China, and belongs to the high population area in the world. Hence, it is impossible to use the river beach land just for flood control neglecting other purposes. Based on the reality of this historical situation, the safe use of floodplain land and reasonable land development is an unavoidable imperative.

However, it is inevitable to further safety develop the beach land of lower reaches for speed economics growth demands since the beach land has not been cultivated as usual land outside the river banks in China. The beach land are becoming focus of local land use because some part of it might be considered as the resources to complement agricultural land transition to urban use. So, research on the safety use of lower beach land is one of important themes at present as it is only one large area of unused land in two large provinces of Henan, Shandong in China.

The lower reach of the Yellow River from Taohuayu in Zhengzhou to its estuary is about 786 km in length (YRCC, 2009a). The upper river section in Henan Province is a typical wandering river course (Qian, 1961) with the distance between banks varying from 5 to 20 km, but usually around 7 km. The riverbed is raised every year(Xu F, 1992; Xu J, 2004). Different from other rivers, the Yellow River beach area is formed of sedimentation from the wandering river course within the two river embankments (Liu S, 1999;Xu J, 2007) In conjunction with the slow subsidence 0.9mm/yearof the North China Plain (Xu J, 2003), the Lower Yellow River reach gradually formed the world-famous "Suspended River" or "River above the Ground", which is generally about 5m higher than the ground outside the river embankments, with sections up to 10m higher. The beach area of the lower reach is about 3500 km^2, accounting for 84% of the total area of the lower river course (Liu Z,2008;

Huangbu X *et cl*., 2003; Sun D *et cl*.,2007; Zhang R, 2004; Yang J,2006; Jiang F, 2002).
As an important part of the river course, the Yellow River beach has multi-functions: reducing flood peaks, depositing sediments, dividing and storing flood waters, and protecting the dams, as well as flood control. Thus, the beach land resources simultaneously have three major missions: the socio-economic development of its own beach area, the social and ecological safety of the beach and bank areas, and Yellow River flood control. These intricate tasks seriously restrict the stable and efficient use of beach land. Lacking compensatory support through funding, policies or projects, floodplain land use efficiency is quite low and socio-economic development faces many difficulties. The beach area has become a under development (poverty) zone across the two provinces of Yu (standing for Henan Province) and Lu (standing for Shangdong Province) （Wang Y, 2006）,where the main factor of poverty is flooding. Based on incomplete statistics, from 1949 to 2003 the lower Yellow River beaches were flooded more than 30 times. After the 1950s, in order to protect riverside land from flood disasters and to stabilize the downstream river course,, huge investments have been used to rebuild massive embankment and dams to transit the river flow more effectively （Wang Y, 2006）.

Recently, some important projects to harness the Yellow River were carried out, such as strengthening dikes by depositing sediments behind them, and regulating river flow and scouring sediments. Especially after the Xiaolangdi Reservoir began operation in 2002 and the continuous regulation of river flow and scouring sediments over nine times, the downstream river channel flood capacity was greatly improved. Flows of less than 4000 m3/s did not overflow the normal river channel (YRCC, 2009b). The flood-protection standard for downstream embankments was also enhanced to "once in a hundred years", that is, the flood flow safely passing Huayuankou, the first hydrological observation station in lower reaches, was raised from 2.2×10^4 m^3/s once in a hundred years to 3.4×10^4m3/s of once in one millennium.

The security standard of beach areas has increased to an unprecedented level, basically with no flooding of the beach areas in the average year. This has supplied an enhanced safety level for land use but also raised new challenges in determining the limits of safe beach use and the safety of residents' life and property.
Many scholars, experts, and government agencies have proposed constructing flood control works，heightening the elevation of village platforms, completing escape roads and relocating low-lying beach villages, as well as developing grassland and husbandry industry, establishing an organic agricultural production base and generally improving the policies supporting beach area development including raising compensation standards（Zhang,2004; Yang,2006; Jiang,2002; Wang,2004; Zhai,2001; Duanmu,2003; Liu, 1993）.

2 CASE STUDY AREA AND DATA SOURCES

2.1 Study case

The Kaifeng Yellow River Floodplain case study area is located in the northern section of Kaifeng. It is bounded on the south by the Yellow River embankment, on the north by the Yellow River water's edge, on the west by the junction of HuihuiZhai village of Shuidao township and Zhongmu County, and on the east by the junction of Yuezhai village of Guying township of Lankao County and Shandong province. The straight-line length of the first section of the Kaifeng Floodplain, comprising the Ming and Qing' old river course, is about 52 km; the river channel is that of a typical, wide and shallow, wandering river with a distance between banks of 5.5 -12.7 km and a river channel of 1.5 -7.5 km in width. Below the first section, from the Lankao east groin head, the following length is about 7 km, and is the river section formed by the Tongwaxiang changing its channel and occupying the Daqing River channel in 1855; the distance between the two banks is 1.4 - 20 km, and the river channel is 1.0 ~ 6.5km wide(Wang Y, 2006). The floodplain region belongs to Kaifeng County, Lankao County, 11 townships in 3 districts of Kaifeng City, and 88 administrative villages. The population of residents who live in the beach areas is 156.8×10^3, the total land area is 31,139.53 hm^2, and the arable land is 12,727.78 hm^2, an average of 800 m^2 of arable land per capita. Being located in the middle of the North China Plain, the historical birthplace of Chinese civilization, and adjacent to modern cities, the problems arising from the coexistence of man and water, and the threat of floods, still exist.

2.2 Beach region boundaries

The lower Yellow River beaches are a special type, different from those in ordinary rivers, and lacking the typical characteristics of floodplain sediment and non-dualistic structure. Before the Xiaolangdi Reservoir was completed, they were often subjected to river erosion and flooding. After the Xiaolangdi Reservoir was completed and the regulation of downstream flows was initiated, the beach region was able to stabilize because of the absence of flooding. Therefore, the current inboard/medial boundary is established by the currently approved minimum flood flow, and the outboard boundary is clearly established by the Yellow River dyke.

Based on the analysis of data for multiple years of flooding from 1992-2007, the frequent flood flow risk design is listed at 4000m^3/s, which is determined by the Yellow River Conservancy Commission (YRCC) at Huayuankou, the first hydrological station of the lower Yellow River floodplain (Huo F , 2009). According to the 20-year series of hydrological statistics from 1986 to 2005, 11 years of flood flows over 4000m^3/s occurred at Huayuankou. However, since the Xiaolangdi Reservoir began working, there have been no flows over 4000m^3/s in the lower Yellow River(Huang, 2006).

Furthermore, there have been manmade nine water-sediment regulations since the Xiaolangdi Reservoir became operational, with 575million tons of sediment washed away in the main channel of the lower Yellow River, resulting in the conveyance capacity enlargement of the main channel from 1800m^3/s before 2002 to 3880m^3/s at present(YRCC,2009b). This basically guarantees that river water would not flow out of the channel under normal

conditions.
Finally, in accordance with plans for harnessing the Yellow River in order to prevent frequent changes of the river channel, in one section of the river in Kaifeng, several training works have been built, such as: Heigangkou Xiayan, Wang Temple, Fu Jun Temple, Autan, Jiahetan, and Caiji . The training works of Dagong, Gucheng, Chanfang and other projects have also been built on the opposite to bank. These projects help to effectively control the river regime and protect the safety of floodplain land use. Based on all of the above, $4000m^3/s$ appears to be a minimum safe downstream flow, and thus is a reliable basis for the analysis floodplain land use.

2.3 Analysis of flood inundation risk

Geographic Information System (GIS) mapping technologies were applied to remote sensing (RS) images obtained by the Thematic Mapper (TM) satellite to extract the river flood transit fringe line for October 16, 1992, September 29, 1994, August 17 and October 4, 1996, September 7, 2002, October 24, 2003, September 22, 2004, April 7, 2006 and June 29, 2007. Using the June 26, 2006 (3700) TM image as background data, these flood regimes in four typical years during this nearly 20 year period are extracted.

With Huayuankou as the control section entrance for flow processing, and Lijin as the exit, floods of different orders of magnitudes where simulated using a two-dimensional water-sediment mathematical model of the Lower Yellow River. Topographic data for the beach regions was obtained from 1:10,000 topographic maps for 1998 produced by the YRCC. The location of training works, anti-flood-danger projects, levee boundaries and additional information was measured using GPS. These data, along with riverway large-section data after the 2004 flood, was applied into 2-dimension water-sediment model to forecast the flood inundation maps in Figure 2 which show submerged areas for supposed floods of different orders of magnitude. These data were then superimposed on the maps of the flood transit region over the past 20 years, and 1:50,000 scale maps were produced showing the pattern of submerged areas for floods of different orders of magnitude (Figure 1).

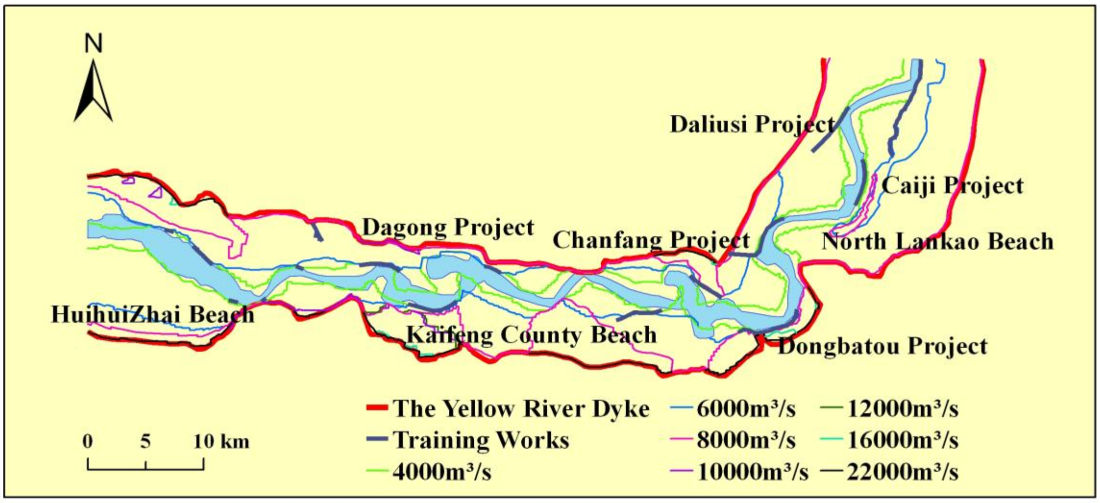

Fig 1 Superpimposed map of Kaifeng Yellow River flood plain for different orders of magnitude of flow

3. CURRENT LAND USE PROBLEMS

Using the superimposed map produced above, the water level line for the 4000m^3/s flow was drawn on a 2007 SPOT2.5 remote sensing image, which was then overlain on a 1:10,000 land use map for 2005 to produce a current (2007) 1:10,000 land-use map. Six types of land use were identified (crop land, forest land , garden plots , water area , residential quarters and industrial-mining land, and unused land) and their areas classified and calculated by pixels' feature from field survey and remote sensing mapping. Based on these statistics, the total land area of the Kaifeng Yellow River Floodplain is 31,139.53 hectares, the main components of which are cropland and unused land, accounting for 40.87% and 35.77% respectively. The remaining areas are rural residential land, brick-tile kilns and so on.

The analysis above of the current status of land use and flood inundation risk, combined with the requirements of "New Countryside Construction planning "(the national program aims to improve rural development), demonstrates that problems with land use in beach regions are concluded as following.

3.1 Flood risk for low-lying villages and cropland

Because of the operation of the Xiaolangdi reservoir, together with water-sediment regulation practices, upstream flooding is controlled effectively and the deepening of the downstream river channel ensures land use safety in downstream beach regions. At present, a flow of 4000m^3/s is basically constrained in the present river channel; there is seldom more than a 6000m^3/s flood flow from upstream of Xiaolangdi to downstream. However, there are no large-scale flood detention projects in the more than 27,000 km^2 Xiao-hua (Xiaolangdi-Huayuankou)drainage basin, and concentrated heavy rainfall still produces large flows downstream, which threatens flooding of beach areas. For example, flows of 22,000m^3/s and 15,300m^3/s occurred in 1954 and 1982 respectively After the Xiaolangdi reservoir was operationally integrated with the Sanmenxia, Luhun, and Gu reservoirs, the 1 in 1,000 year flood flow was reduced from 42,100 m^3/s before the reservoir's construction to a 22,600m^3/s designed flow after construction, under the condition that the Xiaolangdi, Sanmenxia, Luhun and Guxian reservoirs are all closed. However, there is still a 12,900m^3/s peak flow at Huayuankou for a 1ine 100 year flood (Li G, 2001).Consequently, in order to protect residents' lives and the safety of their wealth, villages on low-lying beach areas under the 6,000m^3/s flood-line should be moved outside of the dyke.

3.2 imperfect Infrastructure and poor farming conditions

Due to long-term flood control efforts and flood avoidance practices, the income of the rural population in beach regions is very low. They lack physical infrastructure such as farm irrigation facilities and rural electric power, field roads suffer from a lack of integrated planning, and transportation capacity is generally low. In addition, the land in beach regions is often far away from the villages, so investment in farm irrigation facilities and rural electric power is expensive and maintenance is difficult, again contributing to the lack of farmland infrastructure. Additionally, the beach regions are close to cities, the difference between agricultural and non-agricultural incomes is large, resulting in the construction of a large number of brick-tile kilns in beach regions. Because of the brick-tile kilns, the earth is dug un-orderly, leading to multiple series of horizontal streams which are formed or deepened by flood scour. In addition, some part of higher land and the groundwater depth would be deep (50-60m), deeper than the others regular beach, which makes the use of water more difficult.

3.3 Ecological problems arise from lack of forestry

The soil types in floodplains are mostly sand, requiring wind protection and sand fixation. However, because of long-term flood control requirements, the normal approach of planting tall tree species is inappropriate, so farmland forest networks are not extensively constructed. Since it is dry in winter and spring, blown sand is a serious problem, not only harming crop growth, but also affecting the lives of the population in the beach area and even outside of the dykes.

3.4 human activities harmful impacts on the beach ecosystem

According to our investigation, there are a large number of variously sized brick-tile kilns and barrow pits in the two counties and the one district of the Kaifeng Yellow River beach region, the total area of which is 3305.46 hm^2, accounting for 10.61% of the total land area of the beach. A large number of brick-tile kilns and barrow pits are seriously harmful to agricultural production in the beach area. Firstly, they occupy a valuable land resource, the arable layer has been basically destroyed, and it is difficult to reclaim the land effectively in a short time period. Secondly, the local groundwater is deteriorating. Because the brick-tile kiln factories dig wells nearby, local groundwater depressions are formed, leading to difficulties for local agricultural irrigation. Thirdly, they are harmful to the surrounding ecological environment.

They directly result in landscape fragment, which would cut the wildlife habits, moving way of some animals and reducing the biodiversity. On the other hand, they always become the source of dust or windy erosion to impact on the around areas.

4. SAFETY USE PLAN FOR AVOIDING FLOODING RISK AND ECOSYSTEM PROTECTION

In accordance with the goal of building a new countryside which is productive, orderly, economically well-off and democratic, how should the beach areas within the Yellow River flood channel be managed so that the rural ecological environment is preserved and residents are physically and economically secure and have a rich life? How can rational planning and the layout of the various land uses on the Yellow River beach land best achieve these benefits?

In accordance with the characteristics of Yellow River beach land, combined with land use control principles and land management practices, the following beach zoning land classification and program management system is proposed.

4.1 Ecosystem wetland protection zone

This band is closest to the main river channel, extending approximately 100-250m from the 4000 m^3/s flow water line which is the core area of the Yellow River wetlands. Prohibit any form of exploitation and utilization.

The situation of the river channel has become relatively more stable after recent water and sediment diversions, and it is difficult for a 4000m^3/s current to overflow the river channel. However, in order to avoid flood risk, because of the unique Yellow River bank silt characteristics, these 200 meters areas along the river channel are not suitable for farming. This buffer band ought to guard against the risk of river erosion, and protect the security of farming on the higher terrain. Together with the river channel, the band closest to the river channel is the drainage channel for small or mid-sized floods, as well as the major natural habitat of Yellow River wetland species. So it is important protection zone and belongs to high risk buffer band for outside land use.

4.2 Zone of land suitable for cultivation near river

This zone is located outside the high-risk buffer band closest to the river, roughly between the 4000 and 6000mm^3/s flow water levels. The use of these beaches is basically safe if it can be controlled and used according to the "farmland" standard. Large areas of land within the region are appropriate for farming and can play multiple roles in exploiting and using beach land, such as reducing the flood peak, flood detention, and reducing the flood water level. However, there are a large number of brick kilns in this zone which should be resolutely stopped and the existing settlements relocated to outside the banks as soon as possible.

In fact, there is a production dam at the boundary between the high-risk buffer band closest to the river and the zone of land suitable for cultivation. In principle, this production embankment should be constructed and kept by the people of the floodplain themselves, according to the some safety standards. It is pointed out that the location of the dams always located on the key points of flooding water course, which are directly managed by the Yellow River maintenance department in order to facilitate flood control operations. Furthermore, it is unavoidable to resolve the contradictory goals between flood control and flood plain development through the policy guidance and effective management of these production embankments.

4.3The zone of relatively stable land use

This zone is located outside the zone of arable land near the river, approximately between the 6000 and 8000m^3/ s flow water levels. The area is stable all year, with thick soil, few villages, and sporadic distribution of agriculture production facilities. It is recommended that the zone should be governed in accordance with the "basic farmland" standard in order to improve land use efficiency, increase the income as well improve the living standards of the local people.
At the same time, the advantages of less land pollution of the Yellow River beach area can be obtained if the forms of agricultural production established in this area are based on organic agriculture, green food production, ecological agriculture and high-quality raw material supply.

4.4 The zone of stable land use

This zone is located outside the zone of relatively stable land use, above the 8000m^3/s flow water level, where the soil layer is a thick, mainly silt-based soil, near the embankment and on higher ground. At present the zone has the most concentrated land-use in the beach area, including village land, farmland and other uses. The history of farming is long, and agricultural production is relatively stable and efficient. It is the area of settlement for the main mass of the flood plain population. As a primary place of residence, flood control standards need to meet the requirements for 50-year flood defenses. The need to build village units for the million people living here also provides the opportunity for the implementation of floodplain immigration strategies, and for the development of tertiary industry.
It is recommended that rural settlements within this area rectify existing shortcomings in residential patterns by combining relocation with local integration. These rural settlements mainly include the villages within the floodplain that are near the Yellow River embankment and in urgent need of resettlement. In principle, proceeding from this reality, policies should be formulated to guide the mass of the population in the beach area to gradually move outside the floodplain. Specifically, the villages farthest from the embankment can be reorganized locally with relocation supplemented by using engineering, biological and other measures to regulate land, merge fragmented plots, build terraces, rebuild aquaculture water facilities, regulate settlement sites, and construct ancillary facilities for agriculture such as roads, motor-pumped wells, ditches, slope protection, shelter forest and so on. Clear definition of land ownership, land type, land area, land boundary surveys and the registration of changes in these is also important. These steps will not only increase the area of arable land in the Kaifeng Yellow River beach region, but also fundamentally solve the issues of production and the livelihood security of the resident population

As a result of the favorable geographic conditions of the Yellow River beaches, and the good ecological environment coupled with the unique advantages of excellent tourism resources in the Yellow River itself, Kaifeng could also establish agricultural tourism in the beach region. This could be formatted as a natural, fresh, simple agricultural park with integrated tourism and the participation of the population as a whole. With a local flavor and a cultural connotation, the agricultural park can effectively demonstrate the potential of the Yellow River beach land, and improve the efficiency of its use.

Acknowledgment: Its content does not represent the official position of the Chinese government and is entirely the responsibility of the authors. We are grateful to Ronald Briggs, our adjunct professor of American, for his careful editing of the draft of the text.

BIOGRAPHICAL NOTES

QIN Mingzhou: **Career**: Professor, Vice Dean, Doctoral Supervisor, College of Environment and Planning, Henan University. Director, the Center of Environment and Health Engineering Technology Research, Henan Universities.
Qualifications: B.Sc., Henan University, May 1985; M.S., Henan University, June 1990; Ph.D., Nanjing University, May 1996 (by thesis).
Publication: published articles are over 60; finished books are 12 including 4 books of Chief Editor. The representatives are followed.
(1)Spatial variation of soil heavy metals in the beach of Lower Yellow River: A case study in Kaifeng Section. Geographical Research, 2013,32(3):421-430
(2)The effects of sediment-laden waters on irrigated lands along the lower Yellow River in China. Journal of Environmental Management. 2007,85(4): 858-865（SCI-3）
(3)The Effect of Prior Probabilities in the Maximum Likelihood Classification on dividual Classes: A Theoretical Reasoning and Empirical Testing. Photogrammetric Engineering & Remote Sensing. 2009,75(4)：1109-1117（SCI-2）
Books:
(4)Regulations and Use of the United States land. Science Press. 09/2004. ISBN7-03-014130. (in Chinese).
(5)Cropland protection institution, preferment and case study. *Science Press*.01/2009, (in Chinese)
(6)Enivironment geography. Huazhong Scientific University Press, 04/2010, (in Chinese)
Society Membership:
Director member, Chinese Branch of ILEA (international landscape ecological association)
Vice Director, Educational Council of Chinese Natural Resources Society
Government position
Expert of Approving Council of Henan Province-level Natural Conservation Area
Expert of Approving Council of Henan Province-level Diversity Conservation Area
Funds: the total is over 40 projects.
(1)Natural Science Fund of China. Sustainability and land change in irrigation area along the lower reach of yellow River. 2011-2015
(2)National project of 11-5 Key science supporting program. Cropland sustainable use and

assessment of town-village. 2007-2010
LI Bin, Doctoral Candidate, Henan University
Zhang Pengyan, Doctoral Candidate, Henan University

CONTACTS

Prof. Ph.D QIN Mingzhou,
Adress: College of Environment and Planning, Henan University. Kaifeng City,475004, China.
Tel: 86+378+3881850,86+13723287263
Fax:86+378+3881850
Email: mzqin@henu.edu.cn
Website: http://218.196.194.3/teacher/mzqin.jsp

Mr. Li Bin,
Adress: College of Environment and Planning, Henan University. Kaifeng City,475004, China.
Email:libin@henu.edu.cn
Dr. Zhang Pengyan,
Adress: College of Environment and Planning, Henan University. Kaifeng City,475004, China.
pengyanzh@126.com

REFERENCES

[1]Duanmu L, CHENG G, 2003. Discuss on comprehensive management and development measures of Yellow River Floodplain in Henan. *China Water Resource*, 11: 66-67.
[2] Huangbu X, Zhang C, Liu X,et cl., 2003. Study of hanging river stability assessment the Yellow River in Henan Section. *Yellow River*, 25(4）: 12-14.
[3] Huo F, Lan H, 2009. Study of Mitigation Measures and Analysis of Flood Risk at Floodplain in Yellow River Downstream. *Water Conservancy Science and Technology and Economy*, 15(2): 135-137.
[4] Huang S, Yang Z, Wang Y, 2006. Probability studies of flood plain areas in the lower reaches of the Yellow River. *China Water Resources*, 18: 6-8.
[5] Jiang F, 2002. Discuss on economic belt areas of the Yellow River Floodplain. *China Economist*, 3: 112-113.
[6] Li G, 2001. Discussion About Long Term Harness and Safety of the Yellow River. *Yellow River*, 23(7): 1-4.
[7] Liu J,1993. The initial and development on comprehensive agricultural in Lower Yellow River FloodPlain. *Yellow River*, 2: 55-56.
[8]Liu S, 1999. The Yellow River Floodplain and sub-detention basin risk analysis and mitigation measures --- the Yellow River harnessing and exploitation of water resources. ZhengZhou:Yellow River Water Resources Press.
[9] Liu Z, Qin Y, Jin S, 2008. Study in Treatment of Lower Yellow River Channel and Its

Beach Area's Problem. *Progress In Geography*, 27(2): 32-38.
[10]Qian N, Zhou W, Hong R, 1961. The characteristics and genesis analysis of the braided stream of the lower Yellow River. *Acta Geographica Sinica*, 27(12): 1-27.
[11] Sun D, Li Y, Chen Y, et cl.,2007. Analysis of varying properties with characteristic sections of Lower Yellow River from 1952 to 2000. *Engineering Journal of Wuhan University*, 40(5): 63-68.
[12] Wang Y, Zhang X, Song G, 2006. Issues related to flood plain areas in lower reaches of the Yellow River. *China Water Resources*, 18: 3-5.
[13] Wang Z, Yu X, Xu Y, 2004. A tentative plan for classified management on floodplain area of the lower Yellow River. *Yellow River*, 26(8): 1-3.
[14]Xu F, 1992. Study oftraining issues on meandering river in Lower Yellow River. *Yellow River*, 12: 25-26.
[15] Xu J, 2004. Tendency of sedimentation in the Lower Yellow River influenced by human activities. *Shui Li Xue Bao,*, 2: 8-16.
[16] Xu J, 2007. A study of depositional rate in the north China plain during the past 40000 years, based on ^{14}C dating data from a largewealth of samples. *Quaternary Science,*, 27(3): 437-443.
[17] Xu J, Sun J, 2003 . Sedimentation rate change in the lower Yellow River in the past 2300 years.*Acta Geographica Sinica,*, 58(2): 247-254.
[18]Yang J, Xu J, Liao J, 2006. The process of secondary suspended channel in the lower Yellow River under different conditions of runoff and sediment load. *Acta Geographica Sinica*, 61(1): 66-76.
[19]YRCC(Yellow River Conservancy Commission), 2009a.. Dictionary of the Yellow River (downstream) .http://www.yellowriver.gov.cn/ziliao/hhcd/x/.
[20] YRCC(Yellow River Conservancy Commission), 2009b. Sediment regulation achieved remarkable results in the Yellow River. http://www.yelowriver.gov.cn/
[21] Zhang R, 2004. Suggestions on a General Plan for Lower Yellow River Management. *Yellow River*, 26(5): 1-3.
[22] Zhai J, Hao S, Shen G, 2001. Discussion of the Influence of the Production Banks in the Lower Yellow River Beach Area on the Flood Prevention, *Yellow River*, 27(7): 20-21.
[23]Zhang S, Wang J, Pan Y. 2008. Researches of the Yellow River Farm land Reserve Resources in Henan Province Based on Remote Rensing and GIS Technology. *Areal Research and Development*. 27(6）: 120-123.