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Study on genesis and treatment of the huaihe flood

You Xiang Li[1], Ma Lu[2,3] and Chen Ying[2]

[1]*Anhui Technical College of Water Resources and Hydroelectric Power, Hefei, China*
[2]*Anhui JIANZHU University, Hefei, China*
[3]*Geotechnical Research Institute of Hohai University, Nanjing, China*

ABSTRACT

The flood governance of Huaihe River has a long history. Especially after the establishment of New China, the state has invested huge funds in water conservancy projects, but the problem of Huaihe River flood has not been fundamentally solved. On the basis of previous studies, the reasons for the Huaihe River flood, among which the root causes of the Huaihe River floods are the poor access of the downstream to the sea and low flood discharge capacity, analyzes the shortages of the existing water conservancy projects on the flood governance of Huaihe River and applies the "draining" concept in the flood governance of Huaihe River combined with the successful experience of Mississippi flood governance to put forward a targeted solution accordingly for the Huaihe River flood governance, the sea-entering channel of Huaihe River. As to site selection, the proper project about the selection of channel site is finalized based on the geographical, cultural and economic factors of Huaihe River. Meanwhile, the design of the channel section is to be conducted according to related regulations and standards.

Key words: Huaihe River; flood causes; Mississippi; governance; the sea-entering channel

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INTRODUCTION

Huaihe River basin is located in central China, between the Yangtze River and Yellow River, east longitude 111°55'~121°25', north latitude 30°55 '~ 36°36', just as Fig 1. Its drainage basin strides over 5 provinces: Henan, Anhui, Jiangsu, Shandong and Hubei with an drainage area of 270,000 km^2 (Baidu Encyclopedia. Huai River basin). In history, as the Yellow River once invaded the sea-entering channel of Huaihe River, Huaihe River is now divided into Yishusi river system and Huaihe river system. Huaihe river system is located to the south of Ancient Yellow River and Yishusi River to the north. The drainage basin starts from Mountain Tongbaishan and Mountain Funiushan in the west, faces the Yellow Sea in the east, sets the boundary between Yangtze River by the Dabie Mountain, Jianghuai hills, Tongyang Canal and the southern dyke of Rutai Canal in the south, and set the boundry by Mount Tai and southern dike of Yellow River in the north, adjacent to the Yellow River basin. The total length of Huaihe River is 1000km with a total drop of 196m, and the average gradient of 0.2 ‰. Huaihe River Basin is located in warm temperate semi-humid monsoon climatic province; Qinling-Huaihe Line divides China into south and north. Traditionally, the south of the Huaihe River is regarded as the South of China while the north of the Huaihe River is regarded as the north of China. Huaihe governance has lasted more than 2,000 years since ancient times. Especially since the establishment of New China, the county has attached great importance to the flood governance of Huaihe River and built a large number of key projects, which has played a certain positive effect on the flood governance of Huaihe River, but fails to resolve the problem of the frequent occurrence of Huaihe River floods fundamentally. [1-3]

Based on the analysis of the floods over the past years, the reasons for the Huaihe River are summarized, among which the root reasons for the unsolved problem of Huaihe River floods are the poor access of the downstream to the sea and the crooked middle reaches of the river, resulting in the high drainage water level. This paper discovers that the majority of the existing water conservancy projects are not suitable for the Huaihe River flood governance

by the comparison of different conservancy projects of different river. It means that the essential measures of the Huaihe River flood governance is "draining" rather than "bundles water". Combined with the successful experience of the Mississippi flood governance, the paper analyzes and compares the reasons of Huaihe River and Mississippi River floods and applies the "draining" concept in the Huaihe River flood governance. The key project of Huaihe River governance is the construction of Huaihe River sea-entering channel at the downstream of the Huaihe River. Meanwhile, the location of sea-entering channel is a key problem, concerning the surrounding topography, hydrology, population, economy and so on. This paper settles on a reasonable solution of waterway location by comparing the feasibility of the site selection programs. According to the related regulations, a detailed channel cross-section design has been adopted and reasonable suggestions on the utilization and maintenance of waterways have been proposed.

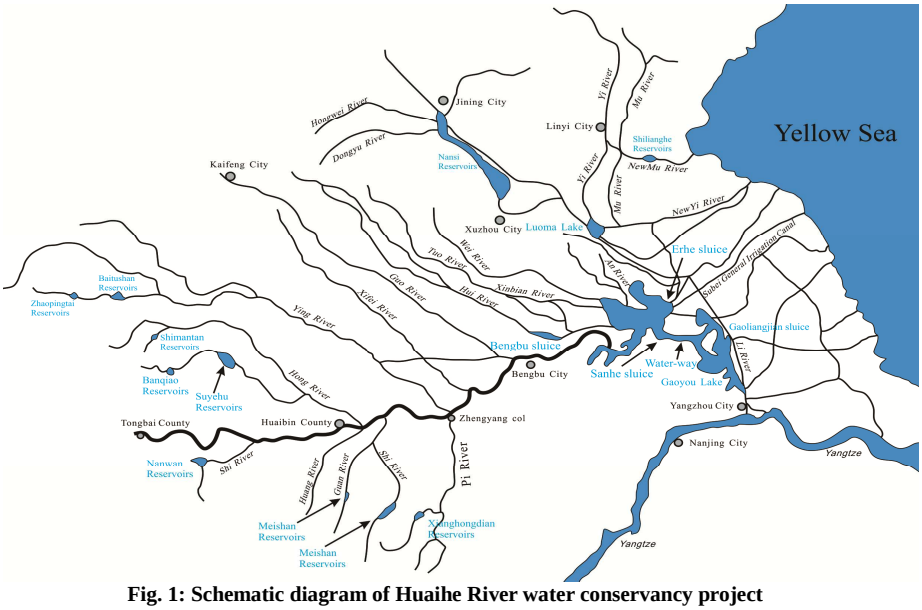

Fig. 1: Schematic diagram of Huaihe River water conservancy project

1. REASON OF HUAIHE RIVER FLOOD

2.1 Terrain topography.

The Yellow river was dug by Southern Song defending generals Duchong in Southern Song Dynasty (1128), since then the Yellow River began to flow into the Huaihe River from Surabaya until the Yellow River changes course during Qing Xianfeng four years (1854)[7].

During these seven hundred years, the Yellow River brought about 70 billion tons of sediment into the old course of Huaihe, the river bed increased 12~14m downstream from Qingkou; During 1938 ~1946, about 100 tons of sediment flowed into the Huaihe River Basin from the Yellow River, resulting in the large tracts of land desertification, branch river and river mouth sedimentation, Hongze Lake sand deposition [10].

The Yellow River flows into the sea through Huaihe River course for a long time, causing the Huaihe riverbed sedimentation, and changed the original appearance of river channel. The river channel features total length of 1000 km, total drop of 200m. The length of upper reaches from Heyuan section to Hongru river mouth is 364km, fall head H=178m, accounting for 89% of the total fall head. The length of middle reaches from the Hongru river mouth to the Sanhe sluice is 490km (Fig. 2), fall head H=16m, accounting for 8% of the total fall head; the downstream section, with Length of 150 km, fall head H=6m, accounts for 3% of the total fall head. Obviously, the upper reach of the Huaihe River is in mountainous area and the middle and lower reach of the Huaihe River is in plain area.

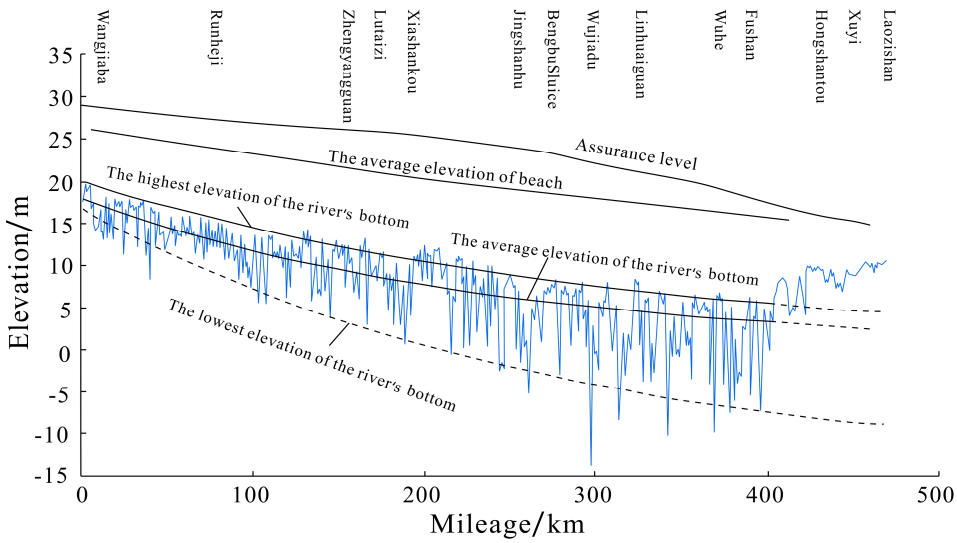

Fig. 2: Longitudinal slope of plane for middle reaches of Huaihe River [10]

2.2 Climate and hydrological

The Huaihe River Basin is located in the North-South transient climatic province, warm temperate semi-humid monsoon climate zone; Average annual rainfall is about 900mm (see Figure Huaihe annual rainfall). The average annual rainfall is above 500mm in flood seasons. The Huaihe river basin and its tributaries upstream, Tongbaishan, Funiushan and Dabie Mountains are located in the summer storm-prone areas. Funiu Mountain is the highest precipitation in the Huaihe River, where the annual average rainfall is above 1,000mm, and more than 1,400mm for the Dabie Mountain area [3].

The average annual runoff of Wangjiaba, Linghuaigang(catchment area of 42,100 km^2), Zhengyangguan (catchment area of 88,600 km^2) are respectively 9.9 billion m^3, 14.8billion m^3 and 250 million m^3. Interannual variability of precipitation and runoff is large and the distribution within one year is very uneven. The east of Huaihe basin faces the sea, the north bordering on the Yellow River, the west and southwest running through Funiu Mountain, Tongbo Mountain, Dabie Mountains, and the northeast towards Yimeng Mountain, with a vast plain located in the central area. After the main stream flows into the middle reaches of Huaihe River, there are HongRuhe River, Luhe River, Shihe River, Pihe River and other tributaries flowing into the main stream from the upper stream starting from Zhengyangguan in the forms of a sector. The main Stream and Tributaries flood peak is easy to threat the security of the middle reaches by the high volume of flood peak formed in the upper stream starting from Zhengyangguan.

2.3 Vegetation destruction and illegal sand mining

The charcoal of German oak is quite popular in South Korea due to the characteristics of anti-combustion. As the largest supplier of charcoal in our country, the charcoal buyers from Japan and South Korea active in the source of Huaihe River for many years around Zhumadian, and the sales volume of charcoal can reach more than 30,000 tons in Korea every year.

A large number of German oak was used for the cultivation of edible fungi. Xixia county and Biyang County are the core forest district of Danjiangkou reservoir area and the Huaihe River protection forest as well as the world's largest place of production and distributing centre of edible mushrooms, which results in the disappearance of large areas of forest[5].

The phenomenon of illegal sand mining in Huaihe is very rampant, the boat can take 100 tons of sand per day, and 200 tons for a ship, which causes a serious threat on the security of Huaihe River dam, and had a bad impact on flood discharge. The security of Huaihe River flood control during flood faces grave security risks, just as sand mining may bring down the whole edifice.

2.4 Reservoir Impact and Poor Management

The reservoir was adopted by many countries as an important role in flood control. While the reservoir use its functions of water storage, it will also affect the river channel's flood discharge, the main drawbacks of large number of reservoir's construction are: The reservoir area will raise the risk of sedimentation, the raising of water level, the reduction of the actual storage capacity, and the reservoir play smaller and smaller role in flood control with the passage of time, and its functions of water storage become more and more weak; The reservoir storage decreases

water volume and flow rate of the downstream, good for the growth of aquatic plants, and block the river, it is not conducive to discharge flood; During the reservoir storage period ,the water volume within the river is small, and the water level is low, only the soil in the lower riverbank contact the river, and the water level will rise rapidly when releasing water through the sluice gates, the sudden rise of the water level due to the pore water pressure increased rapidly, according to the principle of effective stress, the effective stress of the soil will be reduced, thereby reducing the stability of the slope, easily induced landslides, and burst its banks.

Our country attaches great importance to the flood governance and constructed a large number of flood governance projects. However, because the awareness of flood control is weak for some cadres and the masses, attention to governance, underestimate protection, and the daily maintenance and reinforcement in governance flood project can not nip an evil in the bud, and some ineffective implementation, when the flood is coming, from early warning to decision-making can not perform accurately and efficiently, and usually miss the best time for treatment flood.

2. MEASURES OF TREATMENT

3.1 Program comparison

There are nearly 5,700reservoirs, 50000km length of dams, and the number of flood storage area is 42 in the Huaihe River. The level of Huaihe River flood control project far exceeds the Yellow River and the Yangtze River, such flood protection standards should be sufficient, but that is not the case, although these projects in the Huaihe River flood control played a significant role, the Huaihe River floods both in number of times or in disaster losses no less than the Yellow River and the Yangtze River, as a result, the fundamental idea flood management is not "beam flood" but "flood discharge".

Actually, the capacity of discharge flood of Huaihe River is grossly inadequate. The design flow rate is l0000m^3/s in Zhengyangguan of middle reaches of the Huaihe River to Guo River mouth(Huai River outlet), which flood passage zone arrangements flood flow 2,800m^3/s~4,600m^3/s; Guohe River mouth to the design flow rate 13,000m^3/s, in which the flood zone arrangements flood passage flow rate 2,700m^3/s~5,200m^3/s; Moreover, the Cihuaixinghe River and Huaihongxinhe independently bear 2,000m^3/s of diversion task. The design flood level (the waste yellow base surface, later same)in Zhengyangguan is 26.5m, Guo River mouth 23.5m, Fushan18.5m. After 50 years of changes in working conditions, the ability of flood zone has a severe recession in the middle reaches of the river, below Zhengyangguan, in the original design flood conditions, even though the flood zones can be sufficient used in time, the actual flood discharge capacity is also less than the design flow rate 1000m^3/s ~ 1500m^3/s.

There are four draining channel in the lower Hongze lake, River-entering Channel, Sea-entering Channel, Northern Jiangsu Main Irrigation Canal. The design flow rate of the four draining channel is 19800m^3/s~22800m^3/s after the completion of Phase II of River-entering Channel. However, the Phase II of River-entering Channel has not yet started, currently discharge volume of the four draining channel can reach to 15000m^3/s ~ 8000m^3/s with the water level of 15.2m in Hongze Lake, when the water level is 13.5m, the discharge volume only reach to 11000m^3/s~13000m^3/s. Trunk channel flow capacity is less than 90% of design flow. After further management, even though the river can meet the safety discharged requirements of the design water flow, once the upstream of Zhengyangguan occurred 10-year to 100-year flood, the maximum 30 days flood discharge can only reach 15 billion m^3~233 million m^3 in Zhengyangguan trunk channel (containing Huai River), the other 5 billion m^3 ~153 million m^3 detention storage impound in the expression, flood retention area and in the reservoir at the upstream of Zhengyangguan[8].

The above studies proved that the Huaihe River flood discharge capacity is inadequate. The human can not constrained the flooding as a natural phenomenon, or human can not fully control the course of the flood. We should create a harmonious living state for human and the nature, and we should adapt to nature. The construction of the Huaihe River Sea-entering Channel is a good governance flood program by increasing the discharge capacity to control floods.

3.2 Learn from the successful flood governance programs of Mississippi River

The Mississippi River originated is in northwest Minnesota which has an length of 6,020 kilometers and do not have a lot of water, but sediment concentration is very high. With the development of river, the virgin forest and grasslands have been destroyed, a lot of soil erosion, floods frequently occurred. Since 1880, the Mississippi River burst its banks more than 700 times. In 1928, the U.S. government passed the comprehensive renovation of the Mississippi River, "flood control plan", the construction of many projects on its tributaries effective control the flood, the river has become a U.S. domestic traffic artery. The successful flood governance programs of Mississippi River is rare in the world, it has certain reference value for Huaihe River flood governance. The high-flow diversion is the most important project in Mississippi River flood governance project (Fig 3, the Mississippi River flood high-flow diversion project diagram), which is to increase discharge capacity of the river[4].

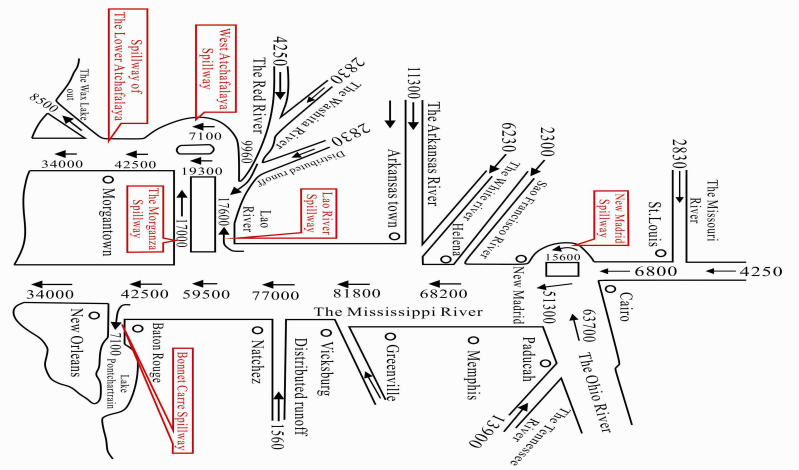

Fig. 3: The Mississippi River flood high-flow diversion project diagram

The Mississippi River flood diversion project get success on the issue of governance, effectively drain the water from upstream rivers into the sea, to ensure the safety of the city along the river. This program is successfully applied "draining" concept, whether the Huaihe River can be used this package? By contrast, under the analysis of the Huaihe River governance makes reference to the possibility of the Mississippi River as Fig 4 and Fig 5.

Riverbed form the riverbed show the characteristic that the gap and gradient in middle and lower reaches of the river were less than the upstream, which makes the riverbed discharged upstream draining fast, short history, and quickly raise the water level of downstream ,slowly discharged, lasted long, easy to form floods[4].
Soil and vegetation: the soil permeability of Mississippi River and the Huaihe River region were inferior, poor drainage, easy to form floods when water quantity is large; vegetation in two rivers are also suffer varying degrees of damage, further exacerbating the riverbank soil erosion, increasing river sediment concentration, high riverbed deposition, not conducive to discharged the flood.

Distribution of rainfall: the annual rainfall of the Huaihe River and the Mississippi River uneven distribution, the Huaihe River is mainly concentrated in the June-September, which account for more than 60% of the annual rainfall. The Mississippi River rainfall mainly concentrated in the March-June. Uneven rainfall, especially in such a short period of rainfall surge that is also an important factor of causing flood disasters; two rivers occurred flood in wide range, and mostly the tributary flooding at the same time, which will inevitably increase the burden of the river, and lead to increased flooding. Once the river floods overwhelmed it will lead to flood. [9]

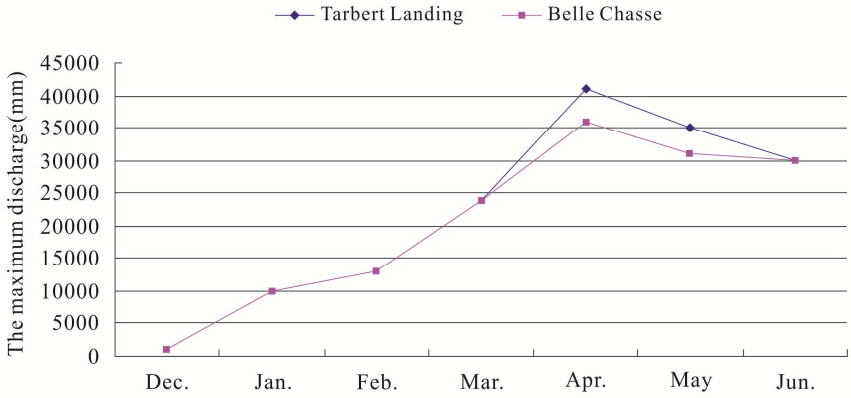

Fig. 4: The Mississippi River part monitoring stations maximum flow diagram [1]

Economic conditions: Economic status of the lower reaches of the Huaihe River is behind the Mississippi River downstream economic, but it is also the advantages of large-scale engineering construction.

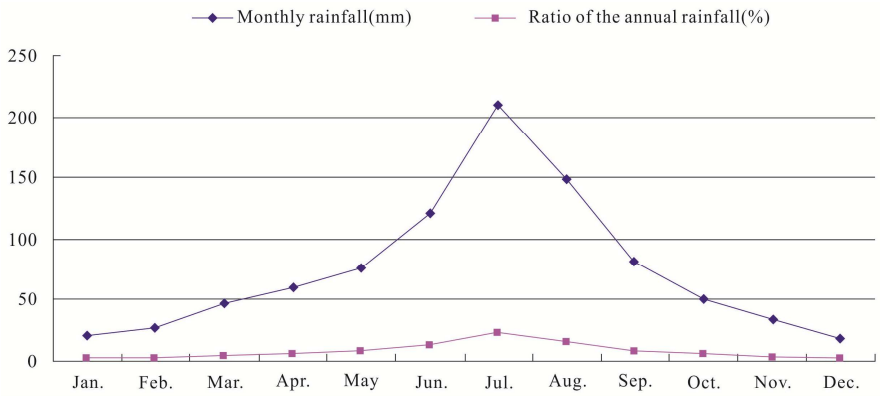

Fig. 5: Huaihe River valley average precipitation of each month for many years [6]

To sum up, the Mississippi River and the Huaihe River are similar to the topography, the annual average rainfall intensity, soil properties and vegetation damage, and the Huaihe River is backward than the Mississippi River in economy, so that is more convenient for the construction, economical and more savings. The Sea-entering Channel played a good role in the flood governance in the Mississippi River, so we can learn the Mississippi River governance ideas to govern the Huaihe River.

3.3 Site selection

The site selection for the Sea-entering Channel as Fig 6 is a very critical issue, and it involves not only whether the terrain and hydrological conducive to the flood discharge, but also involves the development of the local culture and economy, therefore, Be base on ensure the flood discharge smoothly, try to avoid the economically developed, population density or of important heritage areas. Thus, the sites of waterways as follows: the waterways originate from near Xuyi County Heqiao Town Xinjian village group east to the Yijing village, then turn to Jinhu County Zhongdong village, then from Dafeng Caomiao Town Zhuanzhu village into the sea. The program total has a length of about 260km; require 390 million m^3 earth and stone, of which about 12 million stonework m^3, 378 million m^3 earthworks.

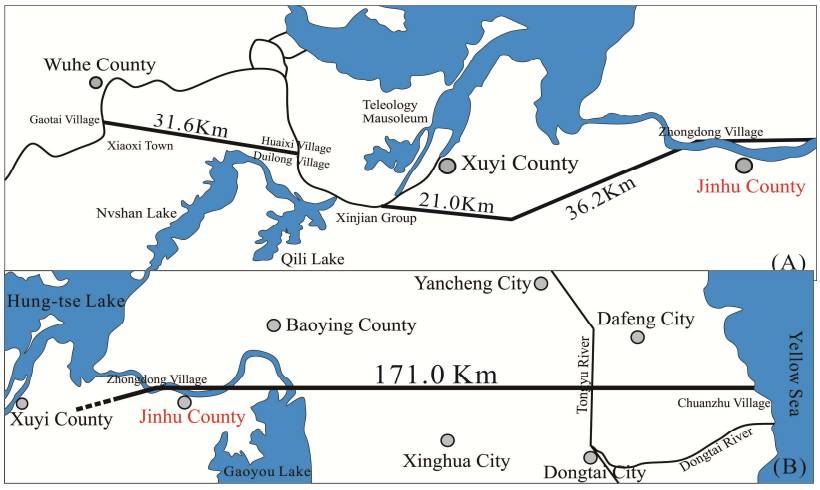

Fig. 6: The **Sea-entering Channel project schematic diagram**

(Fig. A: the first section of the Sea-entering Channel, from Wuhe Country Xiaoxi Town Gaotai Village to Jinhu County; fig. B: the second of section of Sea-entering Channel,from Jinhu Country to Chuanzhu Village)

3.4 Project design

According to historical records, the largest inflows of Hongze lake is 15800m^3/s, the capacity of discharge flood of Huaihe River River-entering Channel is about 10000m^3/s, and the capacity of discharge flood of the North Jiangsu irrigation canal and the waste for Yellow River is about 1000m^3/s. The design flow of established Sea-entering Channel is 2500m^3/s, therefore the flood discharge design of Sea-entering Channel is 3000m^3/s, the check flow is about 3500m^3/s, according to the design size information of established Sea-entering Channel, the channel profile fitting design dimensions:

The excavation width is 300m, channel bottom is 280m, depth of 5m, the height of dam is 10m, the width for top floor is 6m and the bottom is 36m.

According to SL274-2001 (compacted earth dam design specifications), earth dyke slope should not be steeper than 1:1.5, the proposed dam slope of waterways designed to 1:1.5, river slope designed to 1:2. This part of the design conforms to the standard size

The standards for flood control of embankment project[return periods (years)]are 50-100 years, according to GB50286-98 (embankment project design specifications), the project can be classified at level two, the width of top floor is not less than 6m, the proposed embankment meet the requirements of the specification. The specification states that the dam should be reach to more than 6m high, and the top floor of bench is not less than 1.5m wide, so the bench should be set the in the proposed embankment landside, as Fig 7 and Fig 8.

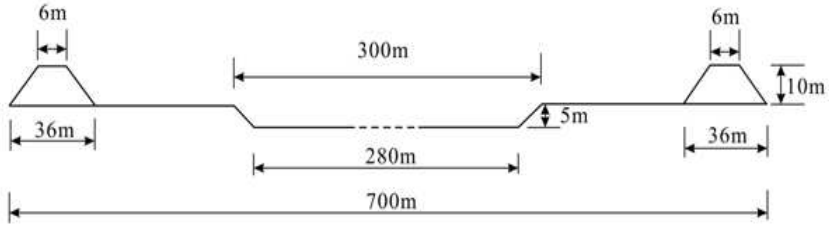

Fig. 7：The profile of Huaihe River Sea-entering Channel

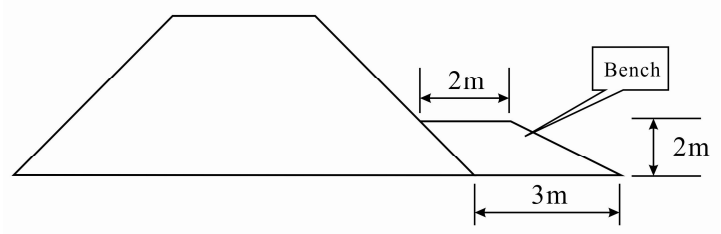

Fig. 8：Embankment bench diagram

CONCLUSION

The Huaihe River flood disaster has a long history, the Huaihe River flood governance also has a long history, especially after the founding of New China, our country invested large injections of funds in building water conservancy projects, but the Huaihe River flooding problem was not solved fundamentally.

The main conclusions of this paper are as follows:

The main causes of flood disasters in Huaihe was put forward, the downstream pour into the sea is not smooth and the middle reaches of the river is bending, all of these raise the flood discharge water level in Huaihe.

This paper pointed out that part of water conservancy project is not suitable for the flood governance of Huaihe, and puts forward the main idea of Huaihe flood governance is not "storage", but "discharge ", namely, Sea-entering Channel is the key project of the Huaihe governance.

This paper put forward specific proposals of proposed Sea-entering Channel, waterways divided into two sections, the first section starting near the upper reaches of Wuhe County Gaotai Village,the end is in the Huaixi Village and Duilong Village flow into the Huaihe River. The second section section originate from near Xuyi County Heqiao Town Xinjian village group east to the Yijing village, turn to Jinhu County Zhongdong village, and then run into Dafeng Caomiao Town Zhuanzhu village into the sea. The waterways running across the Wuhe County, Mingguang City, Xuyi County, Jinhu County, Baoying County, Xinghua City and Dafeng City.

As sea-entering Channel cross section design, the excavation width is 300m, channel bottom is 280m, depth of 5m, the height of dam is 10m, the width of top floor is 6m, the bottom is 36m. The bench should be set the in the proposed embankment landside, the top floor is 2m, the earth is 3m, height of 2m .

Huaihe River flood control is a big project which cannot be solved completely by any one program. The solution of this paper is just the dominant program of Huaihe. It is necessary to control the Huaihe River floods supported by

the appropriate water conservancy projects, such as strengthening the dyke, river course desiltin, and other water conservancy projects. The Huaihe River need a complete system of water conservancy projects.

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