VANT 149 Research Project Report:

Study on the Forms of Water Conservancy Projects by analysis on the Influence of Topography in Northeast Plain and Yangtze Plain on Precipitation

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Abstract

China is the third largest country in the world in terms of land area, which is 9.6 million square kilometers. It has five types of terrain, including plains, plateaus, mountains, hills, and basins, and five types of climates: tropical, subtropical, warm-temperate, mid-temperate, cold-temperate, and highland. Topography over such a vast land area is the main factor affecting rainfall in each region. In recent few years, China depended on the different water conservancy projects, such as dams and reservoirs, to deal with the different amount of rainfall in various regions. Since natural rainfall is uncontrollable, we need to transfer it from harmful effects to beneficial effects in our lives, which is the main motivation of our study. The purpose of this study is to determine the exactly form of water conservancy project for regions of Northeast Plain and the Yangtze River Plain by comparing and analyzing the influence of topographic features on rainfall in recent 10 years. We used data analysis methods to compare and analyze data on topography and rainfall in the two regions by studying data from websites and literature.

Introduction

The plain is an area with an altitude of 200 meters or less, with almost no ups and downs and a flat and wide surface. China is composed of three major plains, including the Northeast Plain, the North China Plain and the middle and lower reaches of the Yangtze River Plain. Among them, the Northeast Plain and North China Plain are located in northern China, and the middle and lower reaches of the Yangtze River Plain are located in southern China. The Northeast plain is mainly formed by alluvial rivers such as Liaohe River, Songhua River, Neng River and Wusuli River. As the purpose of this study, water resources projects include dams, reservoirs, irrigation infrastructure and water transmission projects. According to the study, China's water resources are currently facing many problems, with water scarcity posing a growing obstacle in addition to negative ecological, environmental and social impacts (Liu et al., 2013).

Literature

There are some studies researching on the topography and the precipitation. According to Yuan et al. (2014), it focused on the relationship between the duration of daily rainfall in the warm season (May-October) and the topography in Central North China (CNC). This study compared daily precipitation data for 8 years collected by station to analyze the frequency, duration and evolutions of rainfall events and the contour of the topography of CNC (Yang et al., 2014). It found that the higher the terrain is, the lower is the precipitation amount and the number of rainfalls is relatively smaller in areas with mountains and plains (Yang et al., 2014). Using the data of daily precipitation and contour, it finally determined the spatial features of rainfall events in CNC, which can be described as follow: in the afternoon, some rainfalls over CNC firstly over the mountains and propagate southeastward and continuously affect the rainfall downstream; in foothills and plain, the upstream rainfall obviously affect the rainfalls in these areas (Yang et al., 2014) The similar study conducted by Sun et al. (2021) combined the 24 localized extreme hourly rainfall data in 2011-2016 with the topography characteristics over South China to analyze the wind level and directions which would cause the different amount of precipitation and number of rainfall events. Sun et al. (2021) used simulations on different terrain of mountains and plains to get the wind speed and directions and found that the extreme hourly rainfall data would happen under the conditions of low wind speeds and abundant moisture, which indicated the areas of urban agglomerations.

Studies not only focus on the pattern of rainfall but also focus on the application of rainfall pattern. For example, the determination of functions of water conservancy projects to adjust the different precipitation in different areas and different seasons. In the study of Dongfang et al. (2017), it analyzed the rainfall data in the Guizhou basins to determine the effect of the same water conservancy project in different seasons. This study concluded that seasonal change of runoff the river was mainly attributed to precipitation by using analytical methods and multiple linear regression analysis (Dongfang et al., 2017). Moreover, the runoff of the Hongjiadu rivers can be used to judge that the water conservancy project located here should be used as storing water and regulating flowing capacity (Dongfang et al., 2017). There are many studies researching on the application of water conservancy projects by analyzing the monthly or daily precipitation data. In this study, we want to combine the yearly and monthly precipitation data and the topography characteristics and to determine the main function of water conservancy project in the Northeast Plain and the Yangtze River Plain in China.

Methods

The first step is to confirm the exact latitude and longitude of the study area, that is, the Northeast Plain and the Yangtze River Plain, and to find and compare the contour lines of these two areas. Then the annual precipitation data for each province in these two regions are collected for the last ten years and the average precipitation for all provinces in the same region is calculated to obtain the average annual precipitation for the region. The knowledge of topography is then used to further analyze the causes of precipitation, determine the precipitation characteristics of these two regions based on their annual precipitation patterns, and predict the future precipitation in these two regions. For water conservancy projects, the patterns and roles of all water conservancy projects constructed in China are sorted according to the academical articles, and the assumed precipitation patterns and topographic patterns are combined to determine the best form and main function of water conservancy projects that can be used in the region.

Results

This study aims to determine whether the water conservancy should be used for flood control or preventing drought in Yangtze Plain and Northeast Plain by analyzing the influence of topographic feature and precipitation. The exact latitude of Yangtze Plain is

32°36′14″N 94°30′44″E while Northeast plain is 40°39′54″N 74°23′8″W. The altitude of Yangtze plain is lower than 45 meters above sea level while Northeast plain is lower than 200 meters above sea level. Shanghai, Jiangsu and Zhejiang are three main provinces in Yangtze plain. The total precipitation of these three provinces was approximately considered as the precipitation of Yangtze plain. Heilongjiang, Jilin and Liaoning are three main provinces in Northeast Plain. The total precipitation of these three provinces was approximately considered as the precipitation of Northeast Plain. The summer and winter precipitation were also considered for each region as the season precipitation by assuming June, July and August to be the summer and December, January and February to be the winter. The monthly and yearly precipitation data in recent 11 years in three main provinces of each plain were collected and transformed to stacked column chart by Excel.

Figure 1

Data on Yearly Average Precipitation of Shanghai, Jiangsu and Zhejiang in Yangtze Plain from 2010 to 2020

Yearly average precipitation of three main provinces in Yangtze Plain (mm)				
Year	Shanghai	Jiangsu	Zhejiang	Total
2010	1285.32	1013.21	1929.51	4228.04
2011	1103.31	975.57	1256.54	3335.42
2012	1373.45	939.4	1921.03	4233.88
2013	1087.23	864.33	1398.18	3349.74
2014	1349.36	1052.11	1646.54	4048.01
2015	1409.9	1143.96	1831.65	4385.51
2016	1347.67	1166.69	1658.58	4172.94
2017	1337.67	1085.8	1471.92	3895.39
2018	1279.74	1106.72	1430.74	3817.2
2019	1384.55	919.11	1680.51	3984.17
2020	1455.5	1307.04	1581.77	4344.31

Figure 2

Chart of Yearly Average Precipitation of Shanghai, Jiangsu and Zhejiang in Yangtze Plain from 2010 to 2020

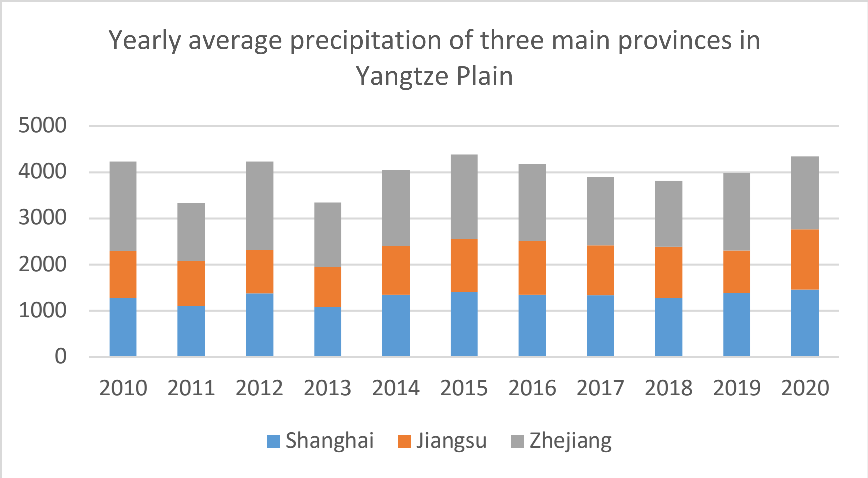


Figure 3

Data on Monthly Average Precipitation of Shanghai, Jiangsu and Zhejiang in Yangtze Plain from 1991 to 2020

Monthly average precipitation of three main provinces in Yangtze Plain(mm)				
Month(1991-2020)	Shanghai	Jiangsu	Zhejiang	Total
June	194.62	148.23	265.39	608.24
July	177.68	206.22	162.6	546.5
Augest	186.07	174.45	179.19	539.71
December	46.46	28	59.07	133.53
January	58.79	34.95	71.75	165.49
February	62.94	40.88	85.46	189.28

Figure 4

Chart of Monthly Average precipitatioin of Shanghai, Jiangsu and Zhejiang in Yangtze Plain form 1991 to 2020

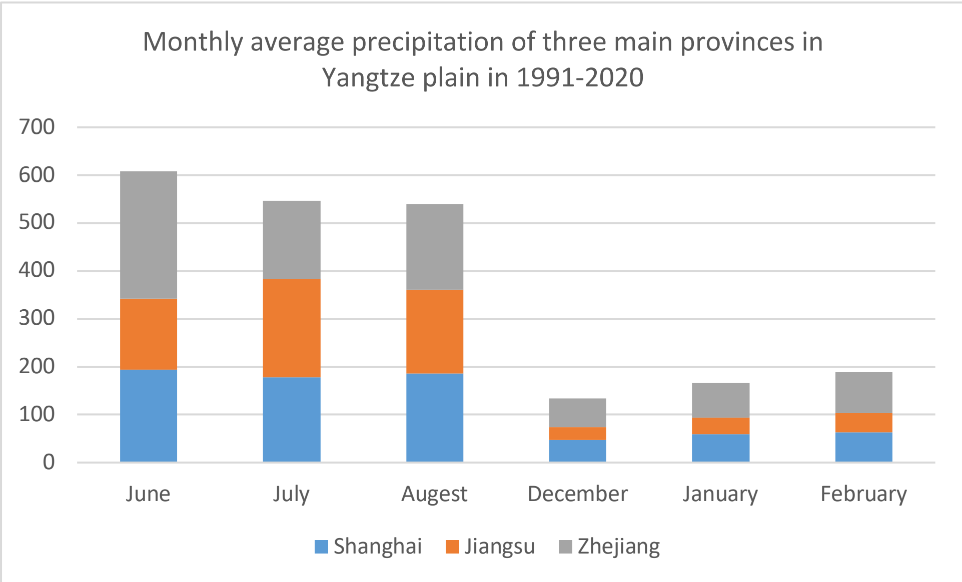


Figure 5

Data on Yearly Average Precipitation in Heilongjiang, Jilin and Liaoning in Northeast Plain from 2010 to 2020

Yearly average precipitation in Northeast plain in China (mm)				
Year	Heilongjiang	Jilin	Liaoning	Total
2010	546.52	755.63	897.77	2199.92
2011	462.18	488.36	587.31	1537.85
2012	636.15	775.91	844.81	2256.87
2013	681.93	772.21	751.51	2205.65
2014	500.81	510.23	448.42	1459.46
2015	530.5	601.68	594.3	1726.48
2016	594.7	694.91	710.97	2000.58
2017	522.48	564.67	555.86	1643.01
2018	627.76	707.93	592.62	1928.31
2019	687.74	687.33	626.22	2001.29
2020	644.8	656.02	757.17	2057.99

Figure 6

Chart of Yearly Average Precipitation in Heilongjiang, Jilin and Liaoning in Northeast Plain from 2010 to 2020

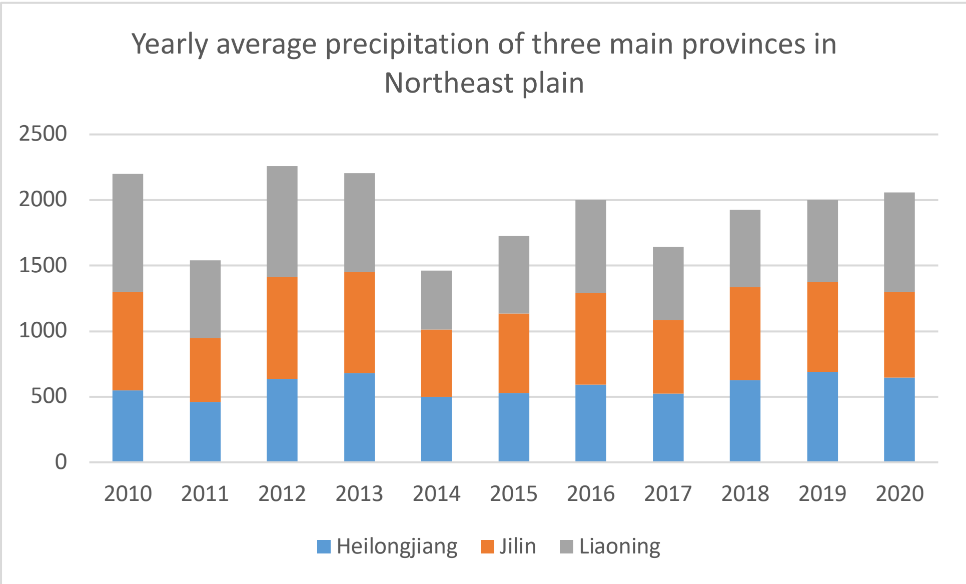


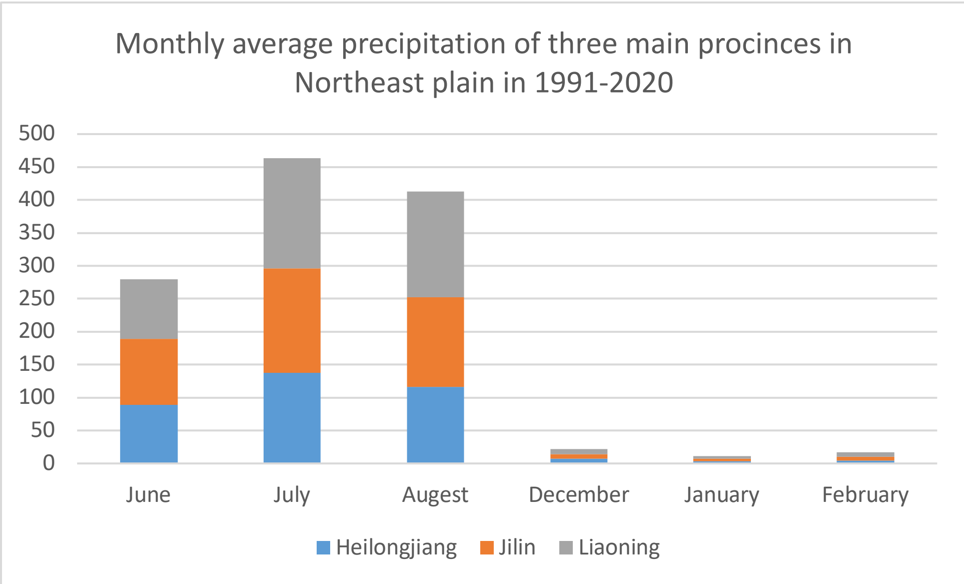
Figure 7

Data of Monthly Average Precipitation in Heilongjiang, Jilin and Liaoning in Northeast Plain from 1991 to 2020

Monthly average precipitation in Northeast plain (mm)				
Month(1991-2020)	Heilongjiang	Jilin	Liaoning	Total
June	89.35	99.87	90.65	279.87
July	137.25	158.71	167.7	463.66
Augest	115.75	136.87	160.27	412.89
December	7.39	6.49	8.02	21.9
January	3.64	3.35	4	10.99
February	4.25	6	6.28	16.53

Figure 8

Chart of Monthly Average Precipitation in Heilongjiang, Jilin and Liaoning in Northeast Plain from 1991 to 2020



According to the above data and charts of precipitation in the Northeast Plain and the Yangtze Plain, it can be described that the yealy precipitation in Yangtze Plain was below 4,500 mm in recent 11 years, while the Northeast Plain did not exceed 2,500 mm. More notably, there is almost a 42-fold difference between the maximum precipitation in summer (June-August) and winter (December-February) in Northeast Plain. The highest value reached 463.66 mm in July, while the lowest value was only 10.99 mm in January. In contrast, the summer precipitation in the Yangtze River Plain is only about 4.5 times the winter precipitation. However, its maximum summer value is greater than that of the Northeast Plain (608.24 mm). According to the latitude and altitude of these two areas, it shows that the Northeast plain belongs to temperate zone and warm temperate zone, with continental monsoon climate. Summer is warm and rainy, and winter is cold and dry. Most of the middle and lower reaches of the Yangtze plain belong to the north subtropical zone, and a few belong to the north edge of the middle subtropical zone, with subtropical monsoon climate. It is hot and rainy in summer and mild and rainy in winter.

The data above shows that the yearly average precipitation of Yangtze plain is larger than that of Northeast plain. This might indicate that there is flood occurring in Yangtze plain while there is drought in Northeast plain.

Discussion

This study aims to determine the water conservancy projects in Yangtze Plain and Northeast Plain in China by analyzing the influence of topography and precipitation. The yearly and monthly precipitation in recent 11 years were collected and analyzed by Excel to show the amount directly and clearly. The latitude and altitude of these two areas indicated the weather pattern. The precipitation data and analysis of topography showed that there is flood in Yangtze Plain while there is drought in Northeast Plain, which can be used to determine that in the Yangtze Plain, the flood control projects need to be set up and the water storage projects need to be set up in Northeast Plain.

In this study, the discovery that flood control projects need to be set up in Yangtze Plain and water storage projects need to be set up in Northeast Plain may be explained by the precipitation pattern in these two areas. According to the collected data, it can be seen that the yearly precipitation is significantly higher in Yangtze Plain comparing to Northeast Plain, especially in summer. The high precipitation would cause the increase of water level of the river and then the lower river will be affected by the flood disasters. Therefore, the flood control projects need to be set in the middle part of the river to control the river level in order to prevent the flood in the lower part of the river. The low amount of precipitation would also bring problems to Northeast Plain especially in winter. The low precipitation and drought weather would reduce the amount of harvest and further affect the agriculture and economic in this area. The best way to solve this problem is constructing the water storage projects to conserve the rain from summer.

According to the analysis, the type of water conservancy projects can be determined. However, this conclusion is not completely conclusive for two reasons. First, the data of precipitation in the two regions is comparatively in small scale. Therefore, the selection of water conservancy projects for these two areas cannot be generalized and there is potential for uncertainty. Second, the water conservancy projects should consider more factors, such as agriculture, hydroelectric power generation and urban water supply and drainage. Since it is a huge task of building a water conservancy project, which would require a lot of money, time and manpower, its multi-functional role needs to be took into account to maximize the benefits. Although this study has some limitations, it provides a good aspect to determine the function of water conservancy projects by comparing the role of different water conservancy projects and the precipitation in different areas. In future studies, using the conclusions drawn from this study and the precipitation in different areas, the choice of water conservancy projects in more areas can be judged, bringing certain convenience to more residents and a certain degree of improvement to the local economic development.

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