

How Migration in China Effect Pollutes Guangdong Province's Marine Environment

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Abstract. At present, population migration is a common phenomenon. People will choose to migrate for various reasons, such as economic depression or future life arrangements, which will promote people to migrate. While migration brings about demographic changes, it also brings about economic changes due to population growth or reduction. Economic growth will be accompanied by industrial upgrading, such as upgrading from agriculture to industry, which can help the region develop and progress rapidly. However, population growth and industrial upgrading will bring negative changes to the community, such as ecological pollution. It is meaningful to understand the pollution problems caused by human migration. Based on the data provided by China National Bureau of Statistics and China Environmental Monitoring Station, this paper analyzes the impact of population migration on regional environment. Taking Guangdong Province as an example, this paper studies the impact of economic growth caused by population migration on the marine environment.

Keywords: Migration, Marine Pollution, Population Growth, Economics Growth

1. Introduction

The environment is vital to human life. Understanding the impact of human behavior on the environment can help us lead a better life. In order to learn more about how human activities affect the environment, we can find the relationship between human migration and environmental pollution. Human migration will bring many changes, such as population growth and economic growth. This is crucial because it can help us know how to develop or discover the mistakes we make in the future environment. This article will take Guangdong Province as an example to discuss the impact of economic development brought about by population growth on the marine environment of Guangdong Province.

2. The relationship between migration and environment

2.1. Hu line

Hu Huanyong found that one of the bases of the Hu Line was population density. Population density reflects not only the quantity of population distribution but also the comprehensive characteristics of the economic development level and ecological environment quality of a regional environmental vast region; The economic development level of a part that can supply a dense population is good, and the environmental conditions cannot be wrong; Generally speaking, the financial status of sparsely populated areas is also necessarily low. The population density characteristics represent the level of economic development and the ecological quality of the environment. Generally, the average population density of a region is calculated as follows

$$P=N/M \quad (1)$$

In the equation, P is the population density (person/km²); N is the regional population (person), M is the regional area (km²) [1]. The figure1 below show the boundary of Chinese population.

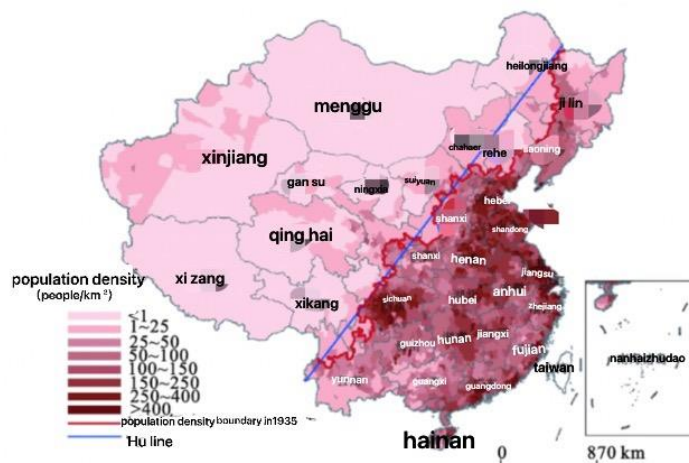


Fig 1. The map of Chinese population density boundary in 1935

Data source: Huan Yong Hu. The Distribution of Population in China, With Statistics and Maps[J]. Acta Geographica Sinica, 1935, 2(2): 33-74.

We can know from this image, the population density of coastal cities in China is much higher than that of inland areas

2.2. Recent situation of China's population

To analyze population data, we need to understand the demographic regulations first. The reason for many errors is that we do not understand the statistical limitations. There are three main methods for China's population data statistical survey. First, the population census has been carried out since 1990, when the mantissa was zero. The data is relatively accurate, but there are still omissions. Since 1949, it has been carried out seven times; Second, a 1% population sampling survey (commonly known as "small census") is conducted in the year "5" for the mantissa, and the data is relatively accurate; Third, the sampling survey of 1 % population change in other years showed rather large data deviation [2].

The data obtained by different sampling methods cannot be mixed and compared. The 10-year census is the most accurate population data, so we analyze it at 10-year intervals, that is, 2000-2010 and 2010-2020.

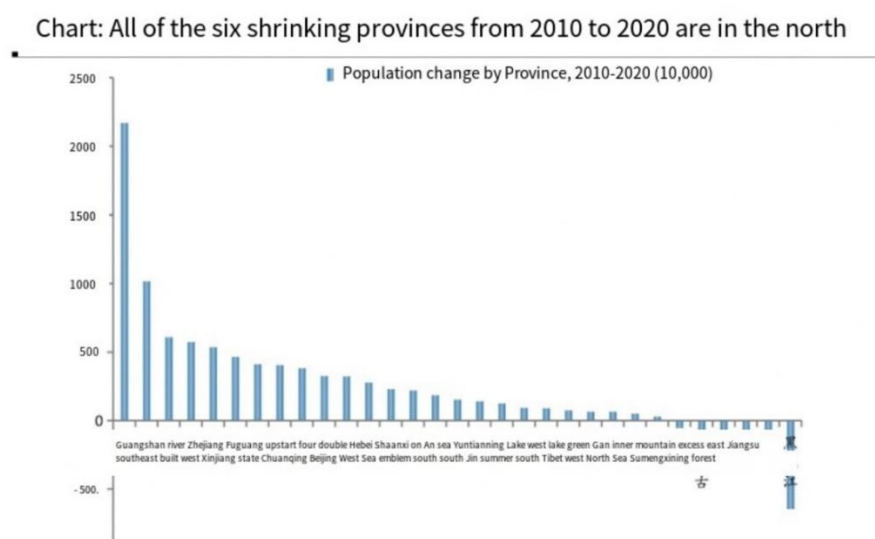


Fig 2. All of the six shrinking provinces from 2010 to 2020 are in the north

Data source : Wang Z, Xia H B, Tian Y, Wang K, Hua H, Geng W J, Tian L, Zheng B L, Zhao J C. A big-data analysis of HU Line existence in the ecology view and new economic geographical understanding based on population distribution. Acta Ecologica Sinica, 2019, 39(14): 5166-5177.

Data show demographic changes in different provinces in China from 2010-2020 drawn by ZePingHongGuan.

The population continues to gather in a few core cities. In the recent ten years, the average annual resident population growth in Shenzhen, Chengdu, and Guangzhou has exceeded 550000, and that in Zhengzhou, Xi'an, Hangzhou, Chongqing, and Changsha has exceeded 300000. From 2000 to 2010 and from 2010 to 2020, among the units at the prefecture level and above in China (data of 10 cities are missing), 236 and 183 have a positive annual resident population growth, accounting for 72.17% and 57.73%, respectively; The number of towns with negative resident yearly population growth in the two periods was 91 and 134 respectively, accounting for 27.8% and 42.27% respectively.

Specifically, Shanghai, Beijing, Suzhou, Shenzhen, and Tianjin were the top five cities with the annual average resident population growth from 2000 to 2010. The top five cities with an average yearly resident population increase from 2010 to 2020 are Shenzhen, Guangzhou, Chengdu, Zhengzhou, and Xi'an.

Among them, Shenzhen, Chengdu, and Guangzhou attract large population inflows with active new economic industries and relatively loose talent policies. The average annual resident population growth of the three cities from 2010 to 2020 reached 720000, 597000, and 582000, respectively; Zhengzhou, Xi'an, Hangzhou, Chongqing, and Changsha have an average annual resident population growth of 397000, 386000, 324000, 321000 and 301000 respectively in recent ten years. These cities are the core cities of the metropolitan area where they are located. Urban development has been relatively fast recently, and the "competition" is intense.

From the perspective of the whole region, the average annual growth rate of the population of the first-tier cities in the past ten years was 2.37%, and the people continued to flow in, but the growth rate slowed down; The average annual growth rate of the population in second-tier cities is 1.91%, and the population continues to flow in, and the growth rate increases slightly. The average annual growth rate of people in the fourth-tier cities is 0.43%, -0.45%, and the population continues to flow out [3].

2.3. Why people choose to move

According to GDP, per capita disposable income of urban residents, and urban political status, we divide prefecture level and above units into first, second, third, and fourth-tier cities. In general, from 2000 to 2020, the proportion of the population in the first-tier and second-tier cities increased from 3.7% and 19.31% to 5.88% and 24.39%, respectively, while that in the third-tier and fourth-tier cities decreased from 30.87% and 42.98% to 30.50% and 37.06% respectively.

From the trend, the average growth rate of the national population was 0.57% and 0.53%, respectively, from 2000 to 2010 and 2010 to 2020, and the average growth rate of the people of the first-tier cities was 3.42% and 2.37%, respectively. The population of the first-tier cities remained concentrated, but the growth rate continued to slow down; In the above two periods, the average annual growth rate of the population of second-tier cities was 1.53% and 1.91% respectively, and the people continued to flow in, and the growth rate increased slightly.

In addition, in the above two periods, the average annual growth rate of the population in the third-tier cities was 0.53% and 0.43%, respectively, slightly lower than the national average growth rate; The fourth-tier cities are only 0.16% and -0.45%, which is significantly lower than the national average—it indicates that the population of the third tier and fourth tier cities is still flowing out.

The main reason cause people move to first-tier or second-tier is the economic gap increases, people cannot find a well-paid job in third and fourth-tier cities, so many people leave small towns, come to big cities, and settle down, leading to population growth in big cities [4].

GDP of provinces and cities in Mainland China in 2020						
National running drawings						
Sorting nuclear province in early 2020 GDP2019 actual growth increment name nominal growth rate of 1						
	Guangdong 110760.94	107671.07	2.3%		3089.87	2.9%
2	Jiangsu province 102719	99631.52	3.7%		3087.48	3.1%
3	Shandong 73129	71067.5	3.6%		2061.5	2.9%
4	Zhejiang 64613	62352	3.6%		2261	3.6%
5	Henan 54997.07	54259.2	1.3%		737.87	1.4%
6	Sichuan 48598.8	46615.82	3.8%		1982.98	4.3%
7	Fujian 43903.89	42395	3.3%		1508.89	3.6%
8	Hubei 43443.46	45828.31	5.0%		2384.85	- 5.2%
9	Hunan 41781.49	39894.14	3.8%		1887.35	4.7%
10	Shanghai 38700.58	38155.32	1.7%		545.26	1.4%
11	38680.6	37114	3.9%		1566.6	4.2%
13	Hebei 36206.9	35104.5	3.9%		1102.4	3.1%
12	Beijing 36102.6	35371.3	1.2%		731.3	2.1%
14	Shaanxi 26181.36	25793.17	2.2%		388.19	1.5%
15	the jiangxi 25691.5	24757.5	3.8%		934	3.8%
16, 25	15 in liaoning	24909.5	0.6%		205.5	0.8%
17	chongqing 25002.79	23605.77	3.9%		1397.02	5.9%
18	24506 in yunnan province	23223.75	4.0%		1276.25	5.5%
19	the guangxi 22156.69	21237.14	3.7%		919.55	4.3%
20	guizhou 17826.56	16769.34	4.5%		1057.22	6.3%
21	Shanxi 17651.93	17026.68	3.6%		625.25	3.7%
22	Inner Mongolia 17360, China	17212.5	0.2%		147.5	0.9%
23	tianjin 14083.73	14104.28	1.5%		20.55	- 0.1%
24	in xinjiang is 13797.58	13597.11	3.4%		200.47	1.5%
25	Heilongjiang 13698.5, China	13612.7	1.0%		85.8	0.6%
26	jilin 12311.32	11726.8	2.4%		584.52	5.0%
27	9016.7 gansu	8718.3	3.9%		298.4	3.4%
28	hainan 5532.39	5308.94	3.5%		223.45	4.2%
29	ningxia 3920.55	3748.48	3.9%		172.07	4.6%
30	qinghai 3005.92	2965.95	1.5%		39.97	1.3%
31	Tibet 1902.74	1697.82	7.8%		204.92	12.1%
National running drawings Data: the statistics around drawing: national running https://blog.csdn.net/weixin_42137700						

Fig 3. GDP of provinces and cities in mainland China

Source: Old bird. A brief analysis of the GDP of China's provinces in 2020. Csdn, 1 Feb. 2021, blog. CSDN.net/weixin_42137700/article/details/113512318.

3. Marine Environmental Problems in Guangdong Province

3.1. Environmental Kuznets Curve

The environmental Kuznets curve refers to the fact that when a country's economic development level is low, the degree of environmental pollution is relatively low, but with the increase of per capita income, the ecological pollution tends from low to high, and the degree of environmental degradation increases with economic growth; When the economic development reaches a certain level, that is to say, after getting a critical point or "inflection point," with the further increase of per capita income, the environmental pollution tends from high to low, the degree of ecological pollution gradually slows down, and the ecological quality gradually improves. The curve is simulated by the relationship model between per capita income and environmental pollution. It is proposed that there is an inverse "U" relationship between economic development and environmental pollution. That is, in the process of economic growth, the ecological situation first deteriorates and then gradually improves. since then

Since then, many foreign scholars have carried out more relevant research based on cross-section and panel data of various countries using the environmental Kuznets curve [5-8].

With the rapid development of China's economy in the past 30 years, the increasingly severe resource and environmental problems have prompted domestic scholars to pay attention to this problem, select research areas with different economic development stages and scales, and use EKC to analyze the relationship between regional economic growth and the environment [9-15].

As a province with a large population in China, Guangdong's labor force population has increased by 4.22 million from 2010 to 2020. At the same time, Guangdong Province is one of the central marine provinces in China, bordering the South China Sea, with a coastline of 3368 km and an area of about 65503 km² within the territorial sea (according to the Guangdong Provincial Marine Environment Quality Bulletin). The marine resources are vibrant. After the reform and opening up, Guangdong's economy has increased. However, with the substantial growth of the economic aggregate, With the accelerated pace of urbanization, the regional pollution environmental load is rising, and coastal areas are increasingly becoming the spatial carrier of pollution output and environmental pollutant emissions [16].

Therefore, this study uses the environmental Kuznets theory and combines the economic growth and ecological pollution data of Guangzhou to understand the relationship between environmental pollution and economic development.

3.2. How to select indicators and analyze data

Data related to economic development, wastewater discharge, and the coastal ecological environment of Guangdong Province from 1991 to 2011 were selected for research. GDP measures the level of economic growth. The above data are mainly from Guangdong Statistical Yearbook and Guangdong Marine Environmental Quality Bulletin over the years.

3.3. Data analysis

Figure 4 were made based on annual GDP growth and effluent emissions.

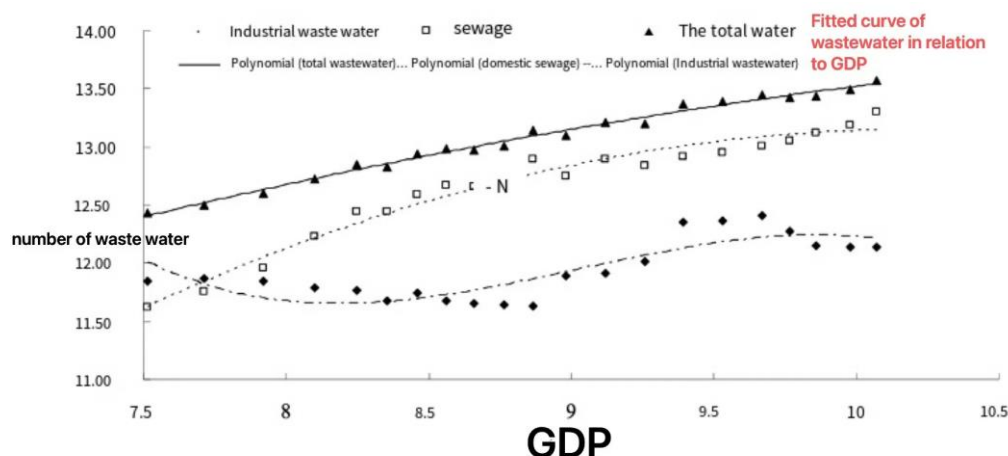


Fig 4. Fitted curve of wastewater in relation to GDP

Data source: Zhuang Dachang, Ye Hao. The relationship between economic development and coastal environmental pollution in Guangdong Province [J]. *Tropical Geography*, 2013, 33 (6): 731-736

According to the images, we can see that the growth of wastewater emissions increases with the development of GDP. At the same time, there is an inverted "U" shape curve and a more obvious buzz curve relationship. It should be noted that: the total wastewater amount is on the left side of the inverted "U" - shaped curve with the domestic wastewater, which has not yet entered the inflection point. However, the fitted curve of industrial wastewater emission is more complicated. It can show a 3-stage change characteristic of decreasing - increasing - decreasing, and then dropping (see Fig.1). That is: even though the decrease in wastewater emission intensity per future unit output value of Guangdong Province is apparent. The increase in the total wastewater emission may persist for extended periods due to the faster growth of domestic wastewater emissions. Therefore, people's environmental awareness must be gradually promoted, and domestic wastewater emissions must be controlled.

The results from the regression of the EKC curve of wastewater emission versus GDP per capita (see Fig. 4) can be found: the total wastewater growth was on the left of the inverted "U" - shaped curve, but the increase gradually slowed. That is, as GDP grows, the economy becomes larger and larger. Economic growth requires more excellent resource investment for countries or regions in the infancy of development. And the improvement of output means the increase of waste and the increase of emissions of pollutants by-products of economic activities, which leads to the decreased quality level of the environment. Especially in the early stages of economic development, the condition of an environmentally contaminated environment deteriorates with economic growth due to low national income, limited government finance, and weak environmental awareness of the whole society, which provides poor government control over environmental pollution. When the national economy develops to a certain level, with the growth of government financial income and the improvement of management ability, more attention is given to the governance of environmental pollution, introducing and enforcing a series of national and local environmental regulations, which can effectively inhibit the excessive emissions of pollutants. Economic development often brings about the upgrade and change of industries, and when economic development reaches a certain level, the structure of industries will escalate. This is the elimination effect of industrial structure change and environmental pollution. Although the proportion of Guangdong Province's secondary industry occupied by wastewater rose from 41.50% in 1991 to 67.72% in 2011 in Guangzhou, the proportion of total wastewater occupied by industrial wastewater generally showed a decreasing trend. This suggests that Guangdong began industrial structure change at the same time as its economic development, and some heavily polluted enterprises were closed, thus making it possible

3.4. Sewage impacts on ecosystems.

According to the successive year Guangdong Provincial Marine Environmental Quality Bulletin, the evaluation results of seawater quality monitoring in the nearshore waters of Guangdong Province showed that: the main items for monitoring the exceedance of waters over the years were inorganic nitrogen and phosphate. The exceedance of inorganic nitrogen and phosphate would lead to eutrophication of seawater, and with the development of industrial and agricultural production in Guangdong Province and the rapid increase in the urban population, the wastewater emission was 25 in 1991 $\times 10^8$ t increased to 79 in 2011 $\times 10^8$ T, especially the rapidly growing domestic sewage. Guangdong Province has a hot climate and a vast quantity of residents for products such as bathing solutions; at the same time, Guangdong is also a significant area of aquaculture in China, where aquaculture has expanded dramatically in nearly 30 years, and shrimp, perlecan, etc. have become the first of its production to become an essential backbone of agriculture in Guangdong Province. Extensive aquaculture caused the deposition of residual bait and fish excrement from the appeal, resulting in the production of ammonia nitrogen, urea, uric acid, and other forms of nitrogenous compounds in their wastewater, also accelerating seawater eutrophication. According to reports, the phenomenon of red tide in coastal Guangdong is increasing year by year, from a time in 1996 to 14 times in 2021.

3.5. Effects of economic development on Biodiversity

The abnormal explosive proliferation of gibberellic organisms has resulted in the disruption of the ecological balance in the sea, and the odd or disrupted relationships and interdependent and mutually constrained relationships among marine phytoplankton, zooplankton, benthos, and swimming organisms, which has dramatically damaged the bait base of the significant economic fishery species, disrupted the average circulation of the food chain of marine organisms, and caused the loss of fish, shrimp, crab, and shellfish decoy fields, Sharper fishery yields; The abnormal burst propagation of gibberellin organisms can cause mechanical blockage of gills in economic biological valves such as fish, shrimps, and shellfish, causing these organisms to suffocate and die; In the late stage of the tide, there is a large number of deaths of gibberellic microorganisms, which, when broken down by bacteria, can cause severe hypoxia in the regional marine environment or produce harmful chemicals such as hydrogen sulfide, making marine organisms hypoxic or poisoning death; In addition, some species of gibberellin organisms contain biological toxins in their bodies or metabolites, which can directly poison dead fish, shrimp, shellfish, and other microorganisms. While influencing the biosphere, red waves also affect human life. Aquaculture established along the seaside experience yields reductions due to the effects of red locks and tourist areas set against the sea close. If the problem of red tide cannot be resolved in Guangdong, the deterioration of eutrophication in water bodies at sea sites will seriously affect the sustainable development of the marine economy.

3.6. Future expectations

In the past 20 years, Guangdong Province has experienced a relatively rapid increase in domestic wastewater emission, gradually becoming the main body of wastewater emission. The increase in domestic wastewater emission is mainly influenced by the urban population's size and the urban residents' living standards. The metropolitan population of Guangdong Province is growing relatively fast, from 1.54 million people in 1991 to 6.9 million people in 2011. During the same period, the average annual income of urban residents increased more rapidly, from 2 752 yuan in 1991 to 26 897 yuan in 2011, a nearly 9-fold increase; The significantly higher consumption levels of urban dwellers, especially the more rapid growth in the consumption of commercial and playgrounds, has led to a rapid rise in the number of domestic sewage emissions at these sites even though Guangdong has started to impose its environmental pollution problems, 109 companies involved in violating the ecological pollution control regulations of Guangdong Province were treated in 2021. those companies got Penalties such as fines and stopovers. Still, Guangdong has insufficient funds for environmental governance, The average share of capital for the treatment and pollution of Guangdong

Province in the recent three years is 1.82%. According to the experience of developed countries, in a period of economic growth, environmental inputs need to cover 1% to 1.5% of GDP to effectively control ecological pollution and reach 3% to make environmental pollution has improved significantly

4. Conclusion

Firstly, in the short term, GDP growth is responsible for the change between the total wastewater discharged and the domestic wastewater discharged, and there is a relatively apparent buzz curve relationship between the total wastewater discharged, domestic wastewater discharged, and GDP in Guangdong Province. The total wastewater is on the left side of the inverted "U" - shaped curve with the domestic wastewater, which has not yet entered the inflection point. Secondly, Guangzhou gradually reduces industrial wastewater after the transition and upgrade of the financial industry, but population growth increases domestic wastewater emissions. Thirdly, The rapidly growing domestic wastewater is severe damage to the environment, and the domestic wastewater has a large number of feces and biological debris, and other organic matter but also contains a large amount of washing water, soap, washing powder residual phosphate, and other nutrient salts. Together with a large amount of aquaculture causing the deposition of residual bait and fish excrement in the bait, the contents of inorganic nitrogen and phosphate in water bodies at littoral sites have shown an increasing year-by-year trend, and water eutrophication has become more severe in the coastal areas.

Although the EKC theoretical surface will go in a good direction with the environment of economic growth, the theory is to be based on the fact that people's lives become better, that social advocacy on pollution problems is in place, and that governments give adequate budgets to manage environmental issues to arrive at. Therefore, in the future, Guangdong should strengthen the construction and enforcement of ecological pollution laws while investing sufficient funds and making mass communications so that common progress in development and environmental governance can be achieved.

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