The Housing Price Change of Sea Level Rise in Coastal Regions in China

Shihan Ma

University of Toronto Mississauga, Mississauga, Canada
3195215248@qq.com

Abstract: The world will face or is already experiencing climate change due to pollution and human activity. Sea level rise is one of the effects of climate change, and many regions are facing a range of natural phenomena, such as flooding, as a result. Most people agree that cities near the sea are undoubtedly the most affected areas. However, coastal cities vary in their economic conditions and geography, and this post is intended to focus on coastal cities within China, exploring what economic impacts sea level rise will have on cities in coastal areas.

Keywords: sea-level rise, coastal, China, house price

1.   Introduction

In recent years, climate change as well has become a hot topic. Global warming, sea level rise, fires, and extreme weather can all occur due to climate change [1]. Among them, sea level rise (SLR) should be a concern because environmental changes will definitely have an impact on some defined areas, like coastal areas. According to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [1], the global average sea level is expected to rise by 0.2 meters and 1 meter by 2050 and 2100, respectively [2]. Meanwhile, China's State Council News in "China's Policies and Actions to Cope with Climate Change" released on October 29, 2008, knows that in the last thirty years, China's coastal sea surface temperature has risen by zero point nine degrees Celsius and coastal sea level has risen by ninety millimeters (Central Committee of the Revolutionary Committee of the Kuomintang of China, 2014). This shows that sea level rise is a global topic now and all coastal areas and low-lying islands are more vulnerable. The relationship between economic development and environmental protection is not always positive, and it is possible that both cannot be achieved.

In the last decade, house prices have also been a big concern, and many people have been working hard to buy a house and constantly making comparisons. In larger cities (Beijing, Shanghai, Guangzhou, Shenzhen), where the economy is more developed and the population is large, buying a house has become even more of a desired goal. Not only do they want to have a place where they can feel warm, but sometimes a house also represents social status. Prices in certain areas, such as school districts, city centers, etc., are only more expensive. Because of the complexity of the meaning that people give to house prices and the increasing number of factors that affect house prices, there are more and more studies on house prices [3].

The issue of sea level rise has led many readers to explore its impact on the economy; for example, some have focused on tourism [4]. According to the research, it was found that the issue of sea level

rise does have an impact on tourism in the future, especially in coastal areas. In addition to tourism, other factors that will be affected by sea level rise also deserve our attention, such as housing prices.

In this paper, we would like to focus our attention on the coastal areas of China based on the condition that the sea level will continue to rise in the future, using some graphs like speculative data on sea level rise [5], Long-term changes of China's coastal and offshore areas sea level during 1960−2021[6]. There are many cities in China that are close to the sea, some of which rely mainly on tourism development to boost the overall economy, and some of which focus on the real estate economy. Two main contrasting groups will be developed later: sea-dependent areas and inland areas, the low-elevation coastal zone (LECZ) and the high-elevation coastal zone. The comparison of these two groups of data will be used to know the specific impact of sea level rise on housing prices.

This essay will describe what might happen by introducing the background and then analyzing two groups by citing data.

2. Literature review

2.1. Sea-level rise and study areas

Climate is a complex issue that has been the subject of much research and discussion, and as a result, it has been studied in a variety of different directions. People's lives are inseparable from their geography, atmosphere, and climate, all of which affect the quality of their lives. In recent years, climate change caused by human activities and changes in nature has brought global attention. It has been researched that the increasing trend in average surface temperature since the late 1970s has already had an impact on the Earth and will continue to change the living conditions on Earth [6]. Climate change causes a range of earth activities and natural phenomena such as floods, hurricanes, mountain fires, and sea level rise [1]. There are parts of high latitudes that have never experienced super-high temperatures that are beginning to face high temperatures, such as the eastern part of Canada, and in China, there are parts of the country that have suffered very severe flooding in the last two years, such as Zhengzhou, Henan Province. Things we need to live are also affected, such as transportation, energy, and agriculture [6].

Coastal economies are highly developed and are the center of development for many countries. There are many delta regions around the globe, some of which have experienced economic growth through land experimentation, river damming, coastal engineering, and tourism [7]. The rate of sea level growth varies across the world's oceans, and the rate of sea level change in China's four major oceans also varies [8]. The impacts on Chinese coastal cities are also different.

2.2. Housing price

House prices are also a controversial topic socially. Some scientists deem that sea-level rise is the paramount part of treat real estate market, especially in the areas that easily to be affected by hurricanes and cyclones (Climate Check). Many types of research show that sea-level rise absolutely has a negative impact on the prices of coastal houses (Murfin and Spiegel; Tyndall; Tarui et al.; Baldauf et al.). In the U.S., it has been found that such impacts (hurricanes, flooding, etc.) due to sea level rise have persecuted land in beachfront cities, resulting in the loss of billions of dollars in beachfront real estate values (climate check).

In China, coastal areas are more populated and economically developed [9]. There have been studies about tourism [3], and there have been studies about why people who live in coastal areas insist on living by the sea [10]. So now there are already some studies that can conclude that sea level rise has an impact on people's normal lives.

In the past, many people could pay all their money to buy their own house, and at that time, all the prices of houses were high. But now, some research shows that more people are considering their cash flow in the future, so the demand for the house is not as high as before.

Depending on the geographic location, houses could have different prices, such as sea view houses and inland houses; houses in high-elevation areas and low-elevation coastal zone (LECZ). As mentioned above, with richer research on house prices, we can also learn more information. Among other things, sea level rise can inundate low-lying parts of the coast, erode beaches, intrude seawater into freshwater aquifers, and have impacts on a wide range of ecosystems [11]. Therefore, it is worth exploring the possibility that the LECZ may have lower prices than the higher elevations.

2.3. Global research

The study, published in the journal Nature Communications, shows that an international team of scientists, including researchers from Rutgers University, discovered that the rate of modern sea level rise began in 1863 and thus began the study [12]. In the U.S., many studies have been conducted on how sea-level rise affects coastal housing prices [13,14]. Countries in Asia that have many cities by the sea have also done some research on this. In Thailand, which is heavily influenced by the natural environment, a survey of the important constituent areas of Bangkok was carried out in 1992 to derive the flood damage losses as a function of inundation depth and duration. Japan's flood disaster encountered with flooding is calculated using the loss rate method [15,16]. Hallegatte et al. assessed the risks that major coastal cities may face in experiencing climate change in the future, as well as their social and economic impacts, and concluded which cities are most vulnerable [16]. However, in China, there is not much information and research on the impact of sea level rise on housing prices, so this paper will mainly analyze this and draw conclusions after comparison.

As can be seen from the above, China has not done much research on the issue of sea level rise on house prices in coastal areas. At the same time, there are not many foreign articles comparing the house prices in different areas to explore the specific impact of sea level rise on house prices. It is hoped that through this article, more information can be obtained about house prices in different locations along the coast by comparing the data. This observation can be used to predict the house prices when facing the future sea level rise.

3. Data

3.1. Sea-level rise

3.1.1. Speculative data on sea level rise

Analysis of satellite altimeter data shows that China's offshore is generally located in the northwestern Pacific region, where the sea level is rising faster. The offshore area of China is generally located in the northwestern Pacific region, where the sea level rises more rapidly (the offshore area of China is the black-boxed area in Figure 1 and Figure 2 [5].

Changes in China's offshore sea level are obvious in Figure 3, accompanied by significant cyclic oscillations of 2-7 years, with faster increases in 1993-1999, 2004-2008, and 2015-2020 by 87 mm, 78 mm, and 73 mm, respectively. 2001-2002 and 2013-2015 saw significant decreases, by 41 mm and 60 mm, respectively. In 2021, China's offshore sea level reaches the highest level since satellite observation records were made, 96 mm higher than the average of 1993-2011. The main research report referred to is Hui Wang et a [6].

As we can see, sea level rise along China's coasts has been occurring for a long time and is not a recent phenomenon. Therefore, it is all the more important for us to pay attention to this kind of problem and care about the impacts it brings to us.
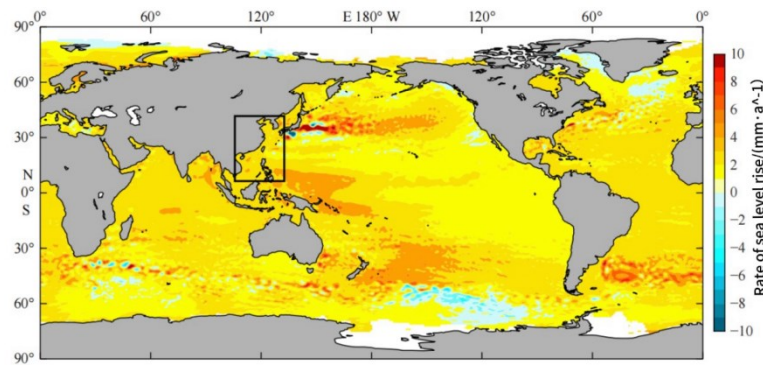
Figure 1: Spatial distribution of global (80°S−80°N) satellite altimeter sea level rise trend from 1993 to 2021
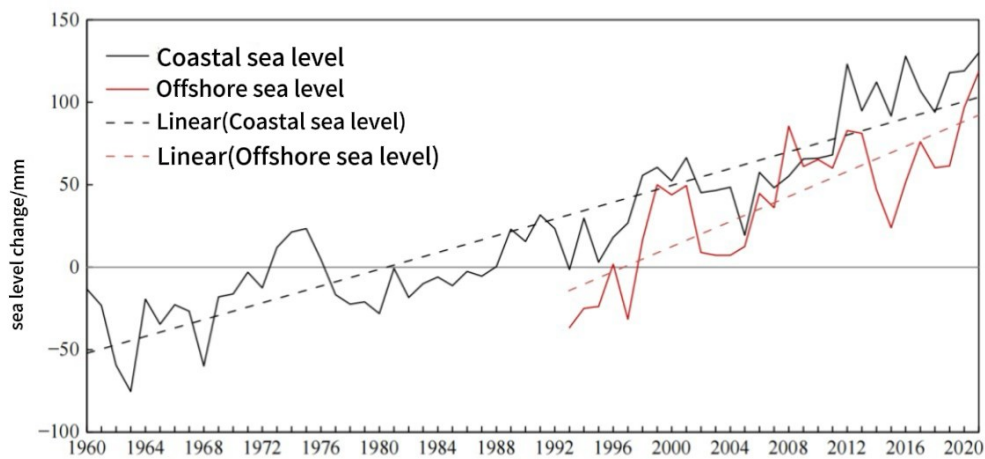
Source: tides & current

Figure 2: Long-term changes of China's coastal and offshore areas sea level during 1960−2021 [6]

3.1.2. Relative sea level trends (tides & currents)

China's coastal sea level is 72 millimeters higher than in previous years, at the highest level ever recorded. Sea level trends measured by tide gauges are local relative sea level (RSL) trends, not global sea level trends. The latest global trends are available from NOAA's Satellite Altimetry Laboratory.

This methodology is cited in this paper because it has been used for at least 30 years of observational data at each site, which is very rich and sufficient. Furthermore, whether RSL was rising or falling was calculated for 142 long-term water level stations. In order to calculate an accurate linear sea level trend, the method averages the measurements on a monthly basis, which prevents the occurrence of excessively high data (tides and currents). Although the study was not centered in China, Figure 3. shows clearly of sea level rise along China's coast.
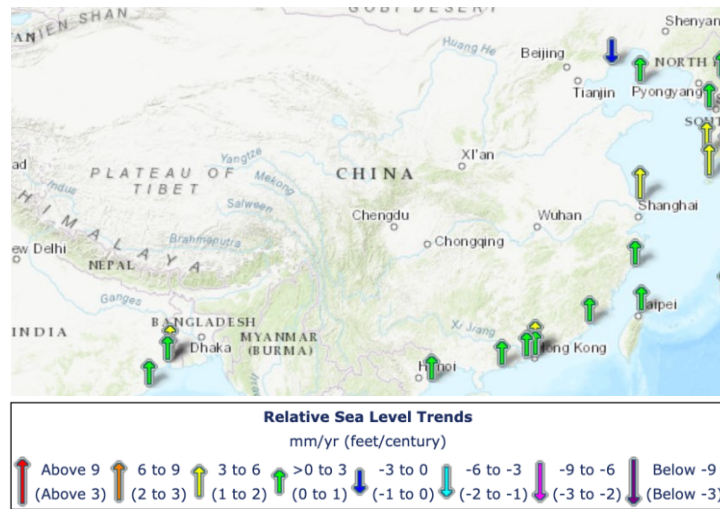
Figure 3: Speculative data on sea level rise
Source: tides & currents

3.2. Cities

3.2.1. Coastal regions vs. inland regions

Table 1: Cities' basic information

| City	Altitude (meter)	Land area (square kilometer)	Sea area (square kilometer)	Population (million)
Shanghai	4	6304	121.85	24.87
Qinhuangdao	4-5.8	7802	1805	3.1
Ningbo	5	9816	8355	9.69
Xiamen	63	1700	333	5.32
Shenzhen	70-120	1997	1145	17.79
Dalian	92.8	12574	30000	7.53
Qingdao	128.5	11282	12240	10.37
Chengdu	500	14335		21.4
Wuhan	37.1	8570		13.64
Xi'an	400	9983		13.07
Nanchang	25	7195		6.56
Changsha	63	11819		10.51
Chongqing	400	82402		31.91
Guiyang	1100	8043		6.4

Source: Study area data
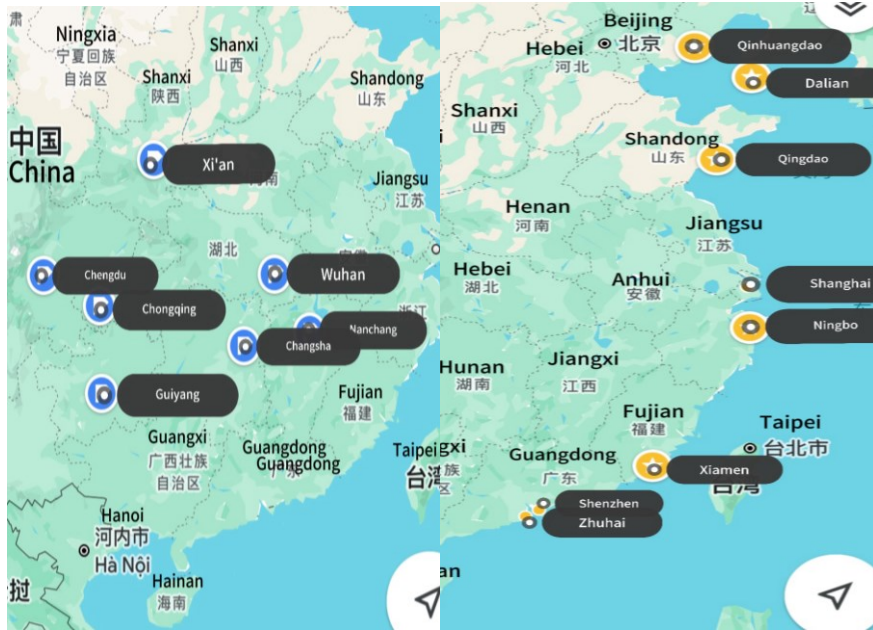
Figure 4: Map of the study area

Since 1978, Chinese policy has attracted many people to move to coastal areas from inland cities, which caused populations in Beijing, Shanghai, Guangzhou, Shengzhen and HongKong showed a rise.

Firstly, the two subjects of the first set of data are coastal and inland areas, and the basic information of seven cities each is counted as an example for comparison.

The Table 1 shows that in general, the elevation of the coastal areas is lower than that of the inland areas (the elevation is the loss of the average height), and the lowest elevation of the coastal areas is already as low as 4 meters, so many people are aware that hurricanes and floods brought about by climate change are likely to affect these areas. The areas that I want to explore as shown in Figure 4.

3.2.2. High-elevation coastal areas vs. low-elevation coastal areas

Table 2: Cities' basic information

| High elevation costal areas	Altitude (meter)	Land are (square kilometer)	Sea area (square kilometer)	Population(million)
Haikou	14.1	3126.82	791	3.2
Beihai	21	3337	60	1.88
Tangshan	27.8	13472	4466.89	7.72
Shenzhen	70-120	1997	523	17.79
Qingdao	128.5	7802	12240	10.37
Low elevation costal areas	Altitude (meter)	Land are (square kilometer)	Sea area (square kilometer)	Population(million)
Tianjin	3.3	11000	11760	13.64
Shanghai	4.5	6340	480	24.87
Qinhuangdao	4-5.8	7802	1805	3.1
Ningbo	5	9816	8355	9.69
Yancheng	5	16931	18900	668.9
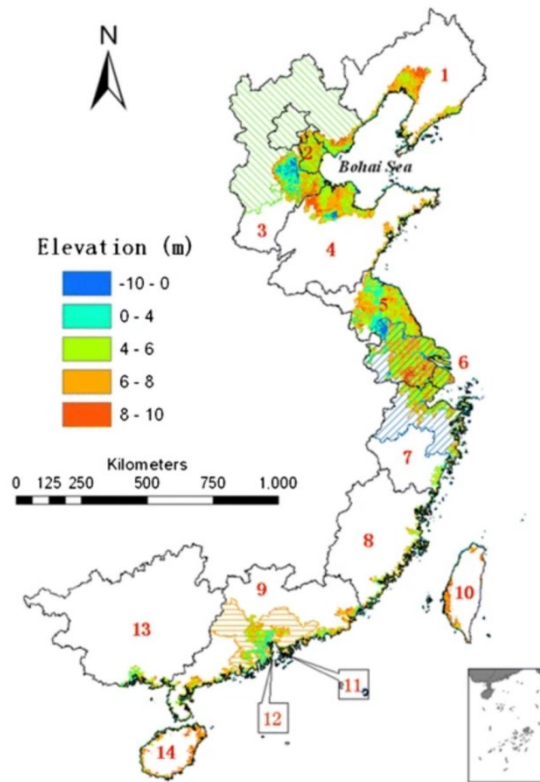
Figure 5: Map of the LECZ in China
Source: Jianli Liu et al., 2013

The second group of 5 subjects is all coastal(see Table 2), but there is also a difference between high and low elevations in coastal areas, so the situation may change again when the criterion of coastal areas is harmonized.

This classification categorizes all cities with an average elevation of less than 10m as low-elevation cities and all cities with an average elevation higher than 10m as high elevation. One of the reasons for this is that in the survey it was found that most of the cities in the coastal area are low elevation. Figure 5 shows the low elevation costal zones in China, like Tianjin, Qinhuangdao, Shanghai.

Basic information about the city can help people understand the collective differences that can exist between coastal and inland cities, such as population and size, which can affect the city's real estate industry. For example, it has been predicted that cities with large populations have high demand, and therefore more people develop real estate. If this happens in a smaller city, there will be an oversupply, and prices are likely to be high; conversely, in a larger city, they may be relatively cheap.

3.3. House price

3.3.1. Coastal regions vs. Inland regions

Table 3: House price in 10 years

Costal	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Shenzhen	33942	45146	47936	43289	51477	53205	54790	56795	57313	57691	64490
Shanghai	20949	24747	23804	45617	51854	50667	50667	50190	51620		51364
Xiamen	13289	13121	13205	32630	46121	45221	45221	45162	47772	53067	33563
Zhuhai	14232	18612	21454	17444	18683	20341	21013	21151	21879	22185	25657

Table 3: (continued).

Ningbo	10708	11229	13325	12916	15654	19260	21408	24401	27157	25656	21016
Qingdao	8902	9230	10518	12682	16749	20027	17594	16536	16692	16605	16003
Dalian	8929	9354	10315	9815	10177	11202	12913	14749	15546	14260	15655
Inland	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Chengdu	6843	7497	8732	8591	10061	13391	13253	13488	14212	15690	17534
Wuhan	8556	10048	11744	11409	15418	16824	17272	15439	16910	15917	16777
Xi'an	6502	6579	8460	6418	7593	11269	12542	12628	13287	14634	17388
Nanchang	7126	8218	8527	10986	10986	12016	12377	12190	12092	11912	11410
Changsha	5866	6406	7688	6775	9001	10573	10370	10094	10374	10688	11355
Chongqing	5486	5485	6792	7095	8973	11820	11797	11312	11872	11854	12315
Guiyang	6005	5943	7236	6028	6666	9311	9394	8906	8813	8297	9449

3.3.2. High-elevation coastal areas vs. low-elevation coastal areas

Table 4: House price in 10 years

High elevation costal areas	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Haikou	7948	9044	11990	7318	9859	14403	15027	15987	15987		19578
Qingdao	8902	9230	10518	12682	16749	20027	16536	16692	16692	16605	16003
Shenzhen	33942	45146	47936	43289	51477	53205	56795	57313	57313	57691	64490
Beihai	4680	4768	5654	4526	5181	6440	6564	6293	6293	5996	7657
Tangshan	5278	4717	5360	6189	7300	7817	8765	10416	10165	9615	11198
High elevation costal areas	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Shanghai	20949	24747	23804	45617	51854	50667	50190	51620	53204		51364
Tianjin	10107	12830	15331	18674	23973	22276	21896	20326	19258	16845	20009
Qinhuangdao	5332	5632	6580	6494	7835	8709	10242	11848	11861	10468	12984
Ningbo	10708	11229	13325	12916	15654	19260	21408	24401	27157	25656	21016
Guangzhou	14612	16384	17633	21480	26868	31658	31990	31915	34250	33549	36086

Since China's reform and opening up in 1978, the government has adopted a strategy that is tilted towards the coastal areas, which have experienced rapid economic development and urbanization, attracting a large number of inland populations to move in [17]. The most populous and economically developed cities such as Shanghai, Tianjin, Guangzhou, Shenzhen, and Hong Kong are located in the lower elevation of the coastal areas.

Through the first table, it can be seen that the rise and fall of the sea level has little effect on the inland areas, and some of the ups and downs are likely to be due to the development of other industries, such as Chengdu, which has become a "new first-tier" city in the last few years, and so the house prices have been affected.

The previous article mentioned the change in sea level growth over a long period of time in the past, so these two tables tally the change in house prices over a 10-year period starting in 2013.

2013-2015 is the previously mentioned period of time when sea levels have declined, and it is clear to see that house prices have been on a significant growth trend over this time period regardless of

region, except for Shanghai (low altitude), which fell a little in 2015. But the original high price of Shanghai makes it the most expensive place besides Shenzhen (high altitude), even with a little drop.

There was a significant sea level rise between 2015 and 2020, and you can see that the time period of sea level rise is not a short one. You can see that prices in coastal cities have all bumped up, although they are still generally trending upwards. For example, from 2015-2016, prices in Zhuhai, Shenzhen (high altitude), and Haikou (high altitude) all fell by about 4,000, while prices in Xiamen and Shanghai all rose by about 20,000 each. Then, Shanghai, Tianjin and Xiamen dropped 1,000 or so in 2016-2017. Prices in Tianjin (low altitude) have been falling since 2017 until 2020. Since 2021, Ningbo's (low altitude) elevation has continued to decline until now, and Shanghai's (low altitude) prices are also showing a downward trend. Finally, by 2023, all high-altitude coastal areas except Shenzhen will generally have lower prices than lower altitudes. Not only because of sea level rise but also because these places rely on sea resources for other economic development, such as transportation and seafood. Those are all shown in Table 3 and Table 4.

4. Conclusion

The effects of global warming are already present in people's lives, and data shows that sea levels are indeed rising, so a number of studies have been conducted as a result. One of these is the sea level rise, which is a historical problem that has been identified since 1963. This study continues to explore the impacts of persistent sea level rise on coastal areas. China is a country with its own sea area, and there are not a few cities near the sea, but many of them have become centers of economic development. In this respect, people are also concerned about the house price, so this paper decides to start from the coastal area to explore the impact of sea level rise on the house price in the coastal area.

Through the following two sets of data: coastal areas and inland areas, coastal high altitude areas and coastal low altitude areas, it can be learned that the house prices in low coastal areas will still be higher than inland areas, and the house prices in low altitude areas will be higher than high altitude areas.

This assessment provides useful information to help better understand future real estate development in coastal areas. In the future, we may be able to have more discussions about economic development in coastal areas to help people choose where they want to settle or where they want to invest in the face of sea level rise.

References

[1] Jean Pierre Feral. IPCC, 2014 - Climate Change 2014: Synthesis Report. 20 Mar. 2015. Accessed 23 July 2024.

[2] Gao Chao, Wang Li, Chen Cai, Luo Gang, Sun Yanwei. (2019)Population and economic risk exposure in co astal region of China under sea level rise. The Geographical Journal. https://www.geog.com.cn/CN/10.11821 /dlxb201908008 (Accessed: 23 July 2024).

[3] Chen, J. , Hao, Q. , & Stephens, M. . (2010). Assessing housing affordability in post-reform China: a case study of Shanghai. Housing Studies, 25(6), 877-901.

[4] Yong, Enn Lun. "Understanding the Economic Impacts of Sea-Level Rise on Tourism Prosperity: Conceptual ization and Panel Data Evidence." Advances in Climate Change Research, vol. 12, no. 2, Mar. 2021, https:/ /doi.org/10.1016/j.accre.2021.03.009.

[5] Sea level trends - NOAA tides & currents (no date) Tides & Currents. https://tidesandcurrents.noaa.gov/sltrends/

[6] Hui, W. et al. (2023) Sea level rise projection in China's coastal and offshore areas, The Geographical Journal. http://www.hyxbocean.cn/en/article/doi/10.12284/hyxb2023096 (Accessed: 01 September 2024).

[7] Jiajia Yuan, Jinyun Guo, Chengcheng Zhu, Cheinway Hwang, Daocheng Yu, Mingzhi Sun, Dapeng Mu, High-resolution sea level change around China seas revealed through multi-satellite altimeter data, 2021, International Journal of Applied Earth Observation and Geoinformation, https://doi.org/10.1016/j.jag.2021.102433

[8] "Factors affecting relative sea level rise in coastal cities and countermeasures--China United Front News Network--People's Network." Cpc.people.com.cn, cpc.people.com.cn/n/2014/0423/c383920-24933913.html.

[9] Neumann, B. et al. (2015) 'Future coastal population growth and exposure to sea-level rise and coastal flooding - a global assessment', PLOS ONE, 10(3). doi:10.1371/journal.pone.0118571.

[10] Ivo Steimanis, Matthias Mayer, Björn Vollan(2021) Why do people persist in sea-level rise threatened coastal regions? empirical evidence on risk aversion and place attachment, Climate Risk Management. Available at: https://www.sciencedirect.com/science/article/pii/S2212096321001066 (Accessed: 01 September 2024).

[11] Low elevation coastal zone (LECZ) (no date) SEDAC. Available at: https://sedac.ciesin.columbia.edu/data/collection/lecz (Accessed: 01 September 2024).

[12] Onset of modern sea-level rise began in 1863, International Study finds (no date) Rutgers University. Available at:https://www.rutgers.edu/news/onset-modern-sea-level-rise-began-1863-international-study-finds (Accessed: 01 September 2024).

[13] Bunten DM, Kahn M (2014) The impact of emerging climate risks on urban real estate price dynamics (No. w20018). National Bureau of Economic Research. https://doi.org/10.3386/w20018

[14] Keenan, Jesse M, et al. "Climate Gentrification: From Theory to Empiricism in Miami-Dade County, Florida." Environmental Research Letters, vol. 13, no. 5, 20 Apr. 2018, p. 054001, https://doi.org/10.1088/1748-9326/aabb32.

[15] Hanson, S. et al. (2010) A global ranking of port cities with high exposure to climate extremes - climatic change, SpringerLink. Available at: https://link.springer.com/article/10.1007/s10584-010-9977-4 (Accessed: 01 September 2024).

[16] Xiaojing Sun, Ruonan Li, Xinmeng Shan, Hanqing Xu, Jun Wang (2021) Assessment of climate change impacts and urban flood management schemes in central Shanghai, International Journal of Disaster Risk Reduction. https://www.sciencedirect.com/science/article/abs/pii/S2212420921005240 (Accessed: 01 September 2024).

[17] Liu, Jianli, et al. "Human Settlement and Regional Development in the Context of Climate Change: A Spatial Analysis of Low Elevation Coastal Zones in China." Mitigation and Adaptation Strategies for Global Change, vol. 20, no. 4, 17 Sept. 2013, pp. 527–546, https://doi.org/10.1007/s11027-013-9506-7. Accessed 4 Nov. 2019.