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Spatial and Temporal Shifts in the Demographic Development of China at the End of the 20th and the Beginning of the 21st Centuries

Ekaterina ANTIPOVA[1]*, Chen LI[1]

**Corresponding author*

[1] Belarusian State University, Faculty of Geography and Geoinformatics, Minsk, BELARUS

antipovaekaterina@gmail.com https://orcid.org/0000-0001-7862-5500

1914391266@qq.com

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ABSTRACT

The article provides an economic and geographical analysis of the demographic processes in China, considering a set of natural and geographic factors, selected to reflect the influence of the state policy of family planning, as well as the policy for the development of separate regions in the period under study. The methodology included the use of geoinformation technologies, classification method and geographical systematization. Based on the identified spatial differences at the level of provinces, radical and previously absent spatial shifts in the demographic processes in China were established for the first time. They consist in the formation of positive and negative dynamics zones, as well as natural increase and natural decline zones. The demographic balance, for the first time calculated for the provinces of China, for 2010 and 2019, made it possible to indicate the dominance of provinces of a progressive type (53.0%) and a zone of provinces of a regressive type (8.8%). The established trend proves not only a differentiation, but also a spatial polarization at the national level and acts as a phenomenon of modern demographic development in China, in the 21st century. The results of the geographical systematization of the demographic space has practical significance as it provides the opportunity to use this methodology at the microgeographic level in other territories and serves as a scientific justification for the development of the directions of China's regional demographic policy.

1. INTRODUCTION

Since the end of the 20th century, the demographic development of China has received a new impetus of scientific interest. This was stipulated by a radical change in the development scenarios due to the phased implementation of the policy of birth control and family planning, along with the national economic policy, and the manifestation of their multifaceted consequences. The influence of birth control policy on economic development in both developing and developed countries has been of scientific interest to researchers since the second half of the 20th century (Heer, 1966; Ashraf et al., 2013; Frejka, Gietel-Basten, 2016). In the context of our study, the experience of the Philippines is of particular interest (Balisacan et al., 2008). Meanwhile, the influence of a versatile policy aimed to accelerate China's economic growth has led to the display of territorial differentiation and polarization in the country's demographic development in the shortest possible time – in less than 30 years of the history of the ancient country. Therefore,

geodemography is the main aspect under research (Fedorov, 1984, 1985). The aim of the study was to substantiate and identify spatial and temporal patterns in the demographic space of China for the period 1990 - 2019 at the level of provinces. Two hypotheses were subject to analysis: 1) since the end of the 20th century, an increase in territorial differentiation in demographic processes can be observed in China; 2) modern spatial and temporal shifts in demographic development occur under the influence of state economic and family planning policies. A significant part of the previous studies of China's demography was related to the study of the general context, age structure, population migration and analysis of family planning policies at the level of the whole country or individual provinces. For the first time, this study presents the results of a poly-scale analysis of the processes of population dynamics, namely natural and migration dynamics, in the case of all provinces of China, using GIS technologies. The study proves scientific novelty by filling the scientific gap in identifying territorial patterns of demographic development of the country over the past 30 years and it is relevant for the development of geodemography. The results regarding the geodemographic typology of the provinces of China are significant for the improvement of the theory and methodology of an economic-geographic study of the population at the microgeographic level. The results obtained with respect to territorial differentiation of demographic processes in China are of practical use, providing the opportunity to develop recommendations for the future regional demographic policy.

2. THEORY AND METHODOLOGY

This section of the article consists of two subsections. In the first subsection, the theoretical basis of the research is presented, namely the scientific direction called 'geodemography', and the most relevant aspects of its modern research in the world are revealed. The second subsection covers the methodology of the conducted research itself, which is based on the principles and approaches of geodemography, and its main stages.

2.1. Theory

The theoretical foundation of this study consists of the principles and approaches of geodemography, the basics of which were laid at the beginning of the 20th century in the USA and the European countries and subsequently developed in the world (Booth, 1893; Fedorov, 1984; Sleight, 2004). The development of theoretical approaches to the geographical study of population as a functional and territorial system, closely related to socio-economic factors, was carried out by Russian scientists (Fedorov, 1985). Due to the possibility of using the results of censuses by census areas, an applied geodemographic research was developed in the 1970s in the USA (PRIZM Premier) and the UK (Census and GeoDems Group (CGG)).

Modern geodemographic research is developing in several directions. The first is represented by the improvement of methodological approaches to the geographical analysis of population (Takashi et al., 2021). The second is aimed at identifying the factors of demographic processes dynamics (Álvarez-Díaz et al., 2021; Nguimkeu and Tadadjeu, 2021). The third is devoted to the establishment of spatial and temporal trends of individual demographic processes (Wisniewski et al., 2021; Rye and Slettebak, 2020) and the study of individual regions and countries (Bleha, 2020).

In the context of this study, the works of Chinese scientists who have deep scientific traditions in the field of population analysis and are actively developing at the present time are of particular interest. Since ancient times, attention has been paid here to the problem of the interrelation between the demographic situation and the socioeconomic development. In the case of pre-Qin population (until the 3rdcentury BC), the dominant view was that more people means more wealth. However, a number of scientists, e.g. Laozi, opposed this idea. Confucianism viewed the prosperity of the population as a sign of good governance of the country (Guangqing, 1995; Cuirong and Xianghe, 2005).

Some Chinese scientists devoted their research to the improvement of methodological approaches to studying the population (Junjie and Peng, 2018), the analysis of separate demographic processes (Qiang and Hu, 2021; Qi et al., 2021), the analysis of demographic situation at the level of separate provinces of China (Chao, 2016), the analysis of China's population theory (Jiangong, 2018), the determination of factors influencing the demographic processes (Guojun et al., 2016; Jingjing et al., 2019), the study of interrelationships of changes in China's population and economic development (Haoran and Xing, 2014). In the last decade, Chinese scientists have paid great attention to the use of the advantages of GIS technologies for the development of the methodology of population geography (Jiaxu and Yinjun, 2019).

2.2. Methodology

The study of the geodemography of China took place in several stages. In the first preparatory stage, we developed a research methodology based on approaches and methods to the study of the geodemographic situation (Fedorov, 1984; 1985), namely, we set the sample of analyzed indicators and reliability of data sources of variables, statistical and mathematical method, method of averages, grouping method, classification method, and cartographic method. Along

with these special methods in geodemography, we used general scientific methods – the method of historical approach and content analysis.

A special role in the study was played by the expert assessment method, which is a search method, derived from the use of the personal opinion of an expert or the collective opinion of a group of experts in creating and testing the hypotheses, in identifying problematic situations and etc. The expert evaluation method is used in situations where the choice, justification and evaluation of solutions cannot be carried out on the basis of accurate calculations. In our research, this method allowed us to prove the influence of factors on the demographic development of provinces using the opinion of the Chinese scientists- experts in the field of geodemography of China (Fig. 1).

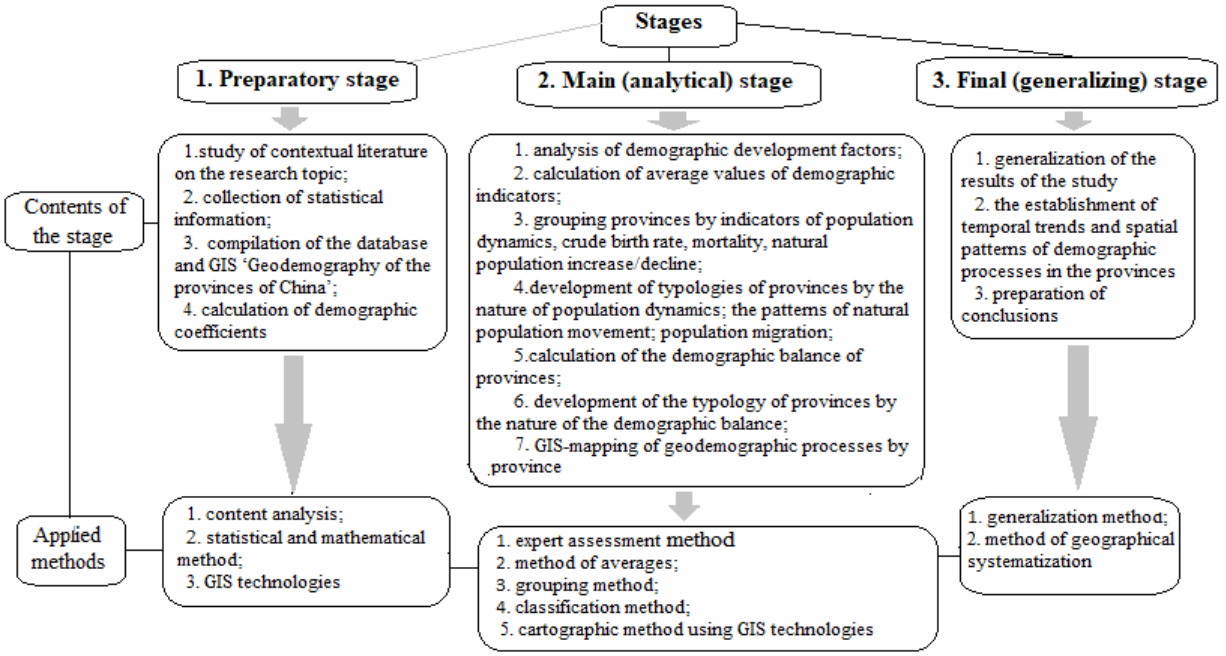

Fig. 1. Methodological scheme of the study of spatial and temporal shifts in the demographic development of China *(compiled by the authors).*

Despite the significant differences in development, the goals and areas of application of geodemographic research in different countries of the world, classification stands as the main method of research. In our case, typologies were taken as a form of classification. This method is the most reasonable and effective, since it allows organizing the large number of indicators that reflect the geodemographic situation of the studied territory and characterize its various connections and relationships (Fedorov, 1984).

In the same stage, the GIS "Geodemography of the provinces of China" was created for 1990-2019 using ArcGIS. The GIS included a total of 50 absolute and relative demographic indicators at the level of all provinces for four years: 1990, 2000, 2010, 2019. (for instance, population size, number of births, deaths, natural increase within four years, population aged 0-14, 15-64, 64+ years within four years, calculation of the demographic balance within two years and the corresponding relative coefficients (annual population growth rates for 1990-2000 and 2000-2019, crude birth rate, crude death rate, rate of natural increase/decline). The information base was represented by the official statistics of the current population registration of the National Bureau of China.

The second main stage included the analysis of historical and modern factors of China's demographic development using the method of historical approach, content analysis and expert assessment. Their average values were also calculated for grouping the provinces according to the main demographic indicators.

The cartographic content created at this stage, consisting of 11 analytical demographic cartograms and cartodiagrams, allows us to see in detail the entire list of the classical absolute and relative demographic indicators calculated (starting from the population size within four years in all the provinces, the annual growth rate to the final calculation of the demographic balance). Next, four consolidated typologies of provinces were developed. The main phase also included the calculation of the demographic balance of China for 2010 and 2019, followed by the elaboration of the typology of provinces, the predominant type being established and substantiated. In geodemography, there are 3 main hypothetical types of balance (Sluka, 2010; Antipova, 2020) and several subtypes: Type 1. Progressive – P (+ N and + M); Type 2. Contrast-factor – CF: Subtype 2.1. based on the natural increase (+ N> - M); Subtype 2.2. based on natural decline (-N> + M); Subtype 2.3. based on migration increase (+ M> - N);

Subtype 2.4. based on migration decline (- M> + N); Type 3. Regressive – R (- N and - M) (Abbreviations: + N – natural increase; - N – natural decline; + M – migration increase; - M – migration decline).

Furthermore, the geodemographic data was mapped using the ArcMap application and a spatial and temporal analysis of the demographic situation in China was carried out with the identification of territorial patterns considering the influence of the dominant factors.

3. RESULTS AND DISCUSSION

3.1. Main factors in the dynamics and distribution of population in China

Various factors have influenced the formation and distribution of population, and the demographic development of China throughout its long history. Given the significant extent of China's territory from north to south and from west to east, a group of *environmental factors* has influenced the population dynamics for many centuries (Jingjing et al., 2019). Thus, the features of the relief, climate, hydrology, soils, geology and the distribution of minerals determined the presence of sparsely populated areas (e.g. the Inner Mongolia Plateau, the Loess and Yunnan-Guizhou, the Tibet Autonomous Region) and densely populated areas (e.g. the middle and lower reaches of the Yellow River and the Yangtze, the North China Plain, Taiyuan in Shanxi in the central region) and provinces within the administrative borders of the country. The *historical factor* had a great impact on the change in population size and its distribution within the territory of China. Over the 5,000-year history, China's population was initially located in two large river basins: the Yellow River basin and the Yangtze River basin. However, as a result of the continuous change of dynasties, their capitals were repeatedly moved. For example, in different periods, the capitals were set in cities such as Chang'an (Xi'an, Shaanxi Province), Xianyang (Shaanxi Province), Anyang (Henan Province), Luoyang (Henan Province), Kaifeng (Henan Province), Nanjing (Jiangsu Province), Beijing, etc. Currently, this factor has a significant impact on the high density and large number of population in Beijing (Jingjing et al., 2019). That is why in recent years the state has specifically issued the Beijing Demographic Control Management Policy. The *economic factor* plays an important role in modern history (Haoran and Xing, 2014; Junjie and Peng, 2018). Historically, the economic centre of China has gradually shifted from west to east. Currently, good transport links in the eastern region provide extremely convenient conditions for its development and ensure a constant influx of young employable population. After the implementation of reform and openness policy, East China became the centre of economic development. The four most developed cities in China (Beijing, Shanghai, Guangzhou, and Shenzhen) continue to attract people from all over the country.

A special place among the factors affecting the demographic development and distribution of the population of China is occupied by the *institutional* one, namely the state policy in the field of family planning and fertility (Guojun et al., 2016; Meng et al., 2017). Since the 1970s, five stages have been distinguished in its development: 1) policy regarding natural population increase (1971-1982); 2) strict family planning policy (1982-2000); 3) relatively free family planning policy (2000-2021); 4) policy of 'Partial permission for two children' (2012-2015), 5) policy of 'Universality for two children' (from 2015 to present). The consequences of this policy are multifaceted and will be discussed in the subsequent sections. One of the obvious positive effects is the promotion of economic growth. Thus, if in 1980, the average monthly wage in China was about US $10, after the full implementation of family planning policy in 1990, it gradually increased to US $27.4. When the fertility rate declined in 2000, the average monthly wage, according to the National Bureau of Statistics of the PRC, soared to US $119.7, then in 2010 to US $468.4, and in 2019 to US $1,160.3.

One of the most effective examples of regional economic policy for the country's geodemography is the 'Western Development' policy, implemented in China since 2000, which aimed at using the remaining economic development potential of the eastern coastal regions to increase the level of socioeconomic development of the western region and strengthen national defence. The 'Western Development' policy was addressed tothe provinces of Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, Inner Mongolia, Guangxi, etc., autonomous regions and municipalities with an area of 6.85 million square kilometres, which is 71.4% of the country. The impact of the 'Western Development' policy will be discussed in the subsequent sections.

3.2. Population size dynamics and spatial distribution

The analysis of the historical dynamics of China's population indicates traditionally low growth rates (0.02%/year) in terms of the concept of 'demographic transition' up to the beginning of the 18th century. In the year 1500, the population of the country was of 50.9 million people. However, by the beginning of the 18th century it tripled; by the beginning of the 20th century it increased 9 times, amounting to 450 million people and by the beginning of the 21st century it exceeded a billion people, increasing annually by 1.2%, thereby taking a historically stable leading position in the world (Table 1). The rural population historically dominated in the structure and numbered about half a billion people at the middle of the 20th century, while only 61.7 million people lived in the cities. By the

beginning of the 21st century, rural population exceeds urban population by more than 1.5 times, yet these proportions rapidly changing due to intensive urbanization. Thus, the annual growth rate of the urban population in the period 1950 - 2000 accounted for 13.6%, whilst the rural population – 1.3%.

Table 1. Historical population dynamics in China.

Year	Total population (million people)	Annual growth of the total population (%)
1500	50.9	-
1600	51.7	0.02
1700	150	1.9
1800	332.2	1.2
1900	450	0.4

Source: compiled by authors based on statistical data from the National Bureau of Statistics of China.

There are several distinctive trends in the current dynamics of China's population. Firstly, the peak of population growth occurred in 1990, after the population increased by 1.6% annually. Subsequently, until 2019, the annual growth slowed down rapidly, down to 0.6%. Secondly, due to intensive urbanization and implementation of reforms and openness policy, in 2010, urban and rural populations in the structure recorded approximately equal numbers, followed by a trend of urban predominance. With a total population of 1435.7 million people, the urban population amounts to 870.0 million. Thirdly, with the general trend of decreasing annual population growth, urban and rural populations are characterized by multidirectional vectors.

The urban population is increasing annually (2.9%), the rural population has been decreasing since 2000 (1.8% per year during 2010-2019) (Table 2).

Table 2. Current population size dynamics in China.

Year	Total population (million people)	Urban population (million people)	Rural population (million people)	Annual growth of the total population (%)	Annual growth of the urban population (%)	Annual growth of the rural population (%)
1990	1156.8	305.5	851.3	1.6	9.9	1.8
2000	1291.8	480.5	811.3	1.2	5.7	-0.5
2010	1363.3	689.7	673.6	0.6	4.4	-1.7
2019	1435.7	870.0	565.7	0.6	2.9	-1.8

Source: compiled by authors based on statistical data from the National Bureau of Statistics of China.

Fourthly, the analysis shows that the dynamics of urban and rural population is also characterized by different intensity. The positive growth of the urban population is slowing down (from 9.9% to 2.9% per year), and the annual decline in the rural population is increasing (from 0.5% to 1.8%). Owing to the dual effect of the national policies (Guo et al., 2020) aimed at narrowing the income gap between urban and rural areas and maintaining the status quo in socioeconomic development, more and more rural people are moving to cities for their development. This largely leads to a decrease in the rural population and an increase in the urban one. The analysis of the spatial distribution of population, conducted at the microgeographic level for the period 1990 -2019, showed that the provinces of China are characterized by differentiation in population size; thus, we identified four population groups as follows: 1) small (less than 20 million); 2) average (20-40 million); 3) large (40-60 million) and 4) the largest (over 60 million). In 1990, about 70% of China's provinces had a population of less than 40 million people (Table 3).

Table 3. Structure of China's provinces by population size (%).

Year	Population scale (million people)			
	The largest (over 60)	Large (40-60)	Average (20-40)	Small (less than 20)
1990	17.6	11.8	38.2	29.4
2000	23.5	17.7	29.4	29.4
2010	20.6	20.6	35.3	23.5
2019	23.5	17.7	38.2	20.6

Source: compiled by authors based on statistical data from the National Bureau of Statistics of China.

They formed two main zones – the western one, with the largest number of small provinces in terms of population (e.g. Tibet, Qinghai, Ningxia – less than 5 million people) and the northeastern one, where the number did not exceed 40 million people. Also, almost every third province of the country concentrated

more than 40 or 60 million people, who were located in the central and southeastern part of China. More than 80 million people lived in provinces such as Shandong and Henan.

In 2019, the national territory maintained its heterogeneity, but the zone with a small population narrowed (from 29.4 to 20.6%) whereas the zone of the largest provinces expanded (from 17.6 to 23.5%). The smallest, by population, are Tibet and Qinghai; the largest are Guangdong, Shandong and Henan. Due to the implementation of the 'Western Development' policy (Deng et al., 2015), the population in the western provinces has increased significantly (e.g. Xinjiang, Inner Mongolia) (Fig. 2).

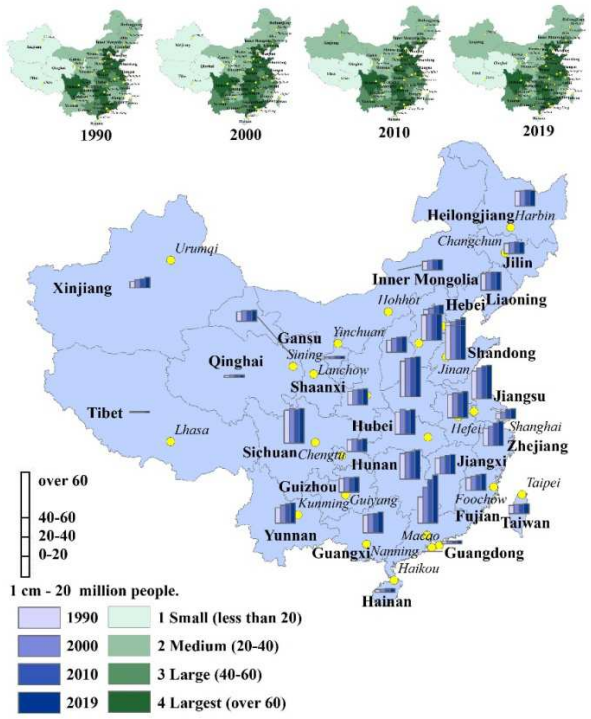

Fig. 2. Distribution of provinces in China by population size (million people), in the period 1990-2019 *(source: compiled by authors based on statistical data from the National Bureau of Statistics of China).*

The analysis of the population dynamics in the provinces of China revealed significant differences among them, indicating radical structural shifts in the nature of the process (the transition in the structure from the dominance of provinces with average and above average annual population growth rates to the dominance of provinces with low annual rates) and a polarization of trends in the period 1990 – 2019 (the formation of provinces with positive and negative population dynamics). If in 1990–2000 all the provinces of China were characterized only by positive dynamics, in 2000–2019 two types of provinces were clearly distinguished in the country, by the nature of dynamics. According to the annual population growth rates, we categorised them into two types: 1) with positive and 2) with negative dynamics of the population. In turn, a significant differentiation among provinces in terms of annual population growth rates (from 0.1 to 3.8%) allowed us to distinguish subtypes within the first type (Table 4).

In 1990–2000, high annual growth rates were typical only to the southern provinces, namely Guangdong and the capital city Beijing (Fig. 3). Population dynamics in Guangdong Province is mainly related to the reforms and openness policy towards Shenzhen as a special economic zone (Chen and de'Medici, 2013), which contributes to the development of the entire province. Beijing is a capital city with comfortable living conditions in all aspects, numerous employment opportunities and a large population that moves here every year. The provinces with low annual growth rates (about 30%) are mainly located in Northeast (Heilongjiang and Liaoning), Central and East (Henan, Anhui, Shandong) and Southwest China (Sichuan, Chongqing, Guizhou, Hunan, Guangxi). The population dynamics in the northeastern region is mainly related to the cold climate, which leads to unsuitable living conditions; so, the relative population growth is slow here (Jingjing et al., 2019). The central and eastern provinces are densely populated, but the population growth has slowed down under the influence of family planning policies (Zhong and Peng, 2020). The rapid population growth in the western region is mainly determined by the 'Western development' policy.

Table 4. Structure of the provinces of China according to the typology by the nature of the population dynamics (%).

Years	Type 1. Provinces with positive population size dynamics (%)				Type 2. Provinces with negative population size dynamics
	Subtype 1.4. With high annual rates (over 3.0)	Subtype 1.3. With annual rates above average (2.0-3.0)	Subtype 1.2. With average annual rates (1.0-1.9)	Subtype 1.1. With low annual rates (0-0.9)	
1990-2000	2.9	20.0	48.5	28.6	0
2000-2019	0	11.8	17.6	64.7	5.9

Source: compiled by authors based on statistical data from the National Bureau of Statistics of China.

The average annual population growth rates have undergone many changes since 2000. First of all, the fundamental difference in the nature of dynamics of the modern period is that provinces with negative dynamics appeared on the territory of China (Hubei (-0.1%) and Jilin (-0.1%)).

Secondly, there are no provinces with high annual population growth rates. Thirdly, the number of provinces with low annual growth rates (over 60%) has increased significantly. Fourthly, the number of provinces with above-average annual growth rates has significantly decreased (from 20.7% to 11.8%).

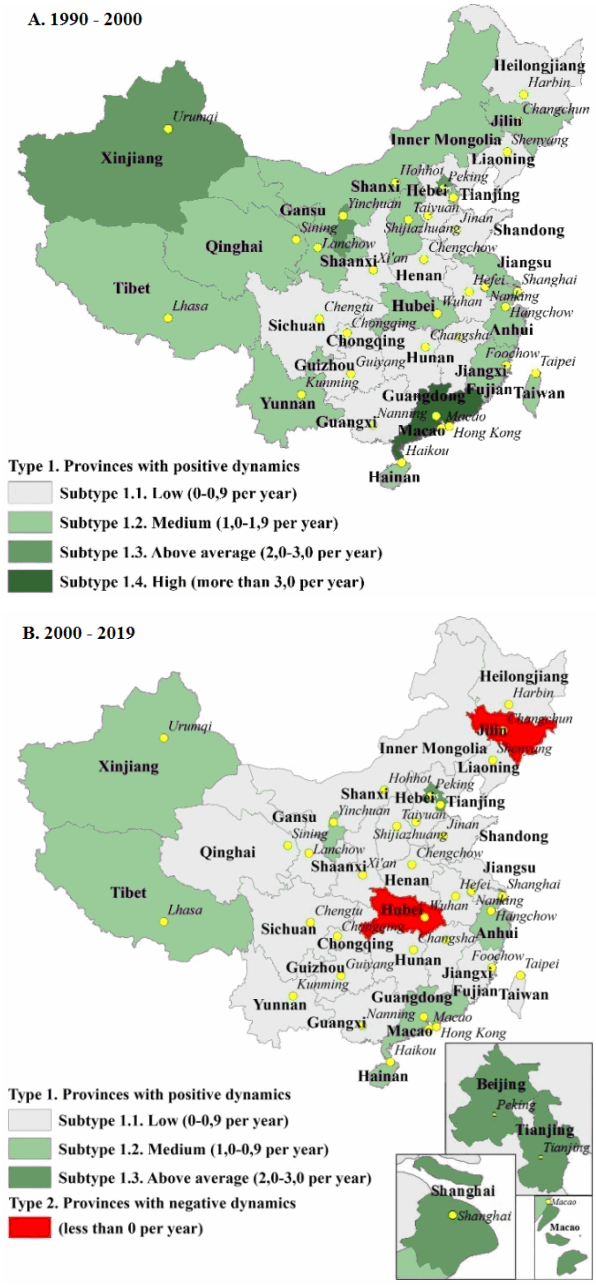

Fig. 3. Typology of China's provinces by the nature of population dynamics *(source: compiled by authors based on statistical data from the National Bureau of Statistics of China).*

In general, since 2000, the annual population growth in all provinces of China has shown a clear downward trend, which is mainly the effect of the implementation of family planning policies. Overall, the map distinctly highlights two large zones with provinces recording positive dynamics (1) continual western and fragmentary eastern with above-average rates and (2) central – with average rates and two small areas of negative dynamics.

3.3. Spatial pattern of the natural dynamics of China's population

Since the end of the 20th century, the natural population dynamics has also been characterized by a number of distinctive features. As a result of the implementation of the family planning policy, the crude birth rate of the population (CBR) decreased by half in 1990 - 2019 (Table 5).

The current birth rate (10.6%) corresponds to the average indicators of Europe and economically developed countries that have undergone the first demographic transition and are at the stage of the second and third demographic transitions. The country also experienced a sharp decline in the total fertility rate (TFR) – from 2.3 to 1.2 in 2010. However, as a result of the implementation of the 'Partial permission for two children' policy since 2012, it increased to 1.5 by 2019. At the same time, this indicator testifies to the transition from an expanded to a simple type of population reproduction in China in the shortest possible time.

The death rate of China's population, as well as the world population as a whole, is characterized by a decrease. For the period 1990 -2010, the crude death rate (CDR) decreased from 6.8 to 5.9‰. However, as a result of demographic aging, it increased in 2019 and amounts to 6.4‰. As a result of the established trends in the birth rate and death rate, natural growth is still recorded in the country, but it declined by almost three times over the years 1990–2019, from 14.2 to 4.2 ‰.

The analysis of the natural dynamics of China's population at the microgeographic level revealed both differentiation and polarization. The differentiation consists in significant disparities in the rate of natural increase (RNI) between provinces, ranging from 0.5‰ in Hong Kong to 10.1‰ in Tibet. Polarization consists in the establishment of multidirectional vectors in the natural dynamics among provinces – increase and decrease. As a result, we identified two types of provinces on the territory of China based on to the character of natural dynamics of population: 1) provinces with natural increase with the corresponding subtypes depending on the values of the RNI indicators and 2) provinces with natural population decline (Table 6).

In the period 1990-2019, there have been radical shifts in the natural dynamics of the population. In 1990, provinces with a high natural increase prevailed in the national territory – more than 10‰; therefore this was the dominant zone. In the east of the country, there were isolated provinces (Beijing, Zhejiang, Liaoning, Tianjin, Hong Kong), where the RNI was less than this value. The minimum value in the

country (3.8‰) was recorded in Shanghai. By 2000, as a result of the implementation of family planning policy, natural growth recorded a general decline (Zhong and Peng, 2020).

Table 5. Variation of indicators related to population natural dynamics in China (‰).

Year	Crude birth rate (‰)	CBR trend	Total fertility rate	TFR trend	Crude death rate (‰)	CDR trend	Rate of natural increase (‰)	RNI trend
1990	21.0	Decrease	2.3	Decrease up to 2010 with subsequent growth	6.8	Decrease up to 2010 with subsequent growth	14.2	Decrease
2000	11.8		1.3		6.2		5.6	
2010	11.0		1.2		5.9		5.1	
2019	10.6		1.5		6.4		4.2	

Source: compiled by authors based on statistical data from the National Bureau of Statistics of China.

Table 6. Structure of the provinces of China according to the typology based onthe character of the population natural dynamics (%).

Year	Type 1. Provinces with natural population increase				Type 2. Provinces with natural population decline
	Rate of natural increase (RNI)				
	Subtype 1.1. With high natural increase (over 10‰)	Subtype 1.2. With above-average natural increase (7-10 ‰)	Subtype 1.3. With average natural increase (4-7 ‰)	Subtype 1.4. With low natural increase (0-4 ‰)	
1990	82.4	11.8	2.9	2.9	0
2000	17.6	20.6	29.4	29.4	2.9
2019	2.9	11.8	38.2	35.3	11.8

Source: compiled by authors based on statistical data from the National Bureau of Statistics of China.

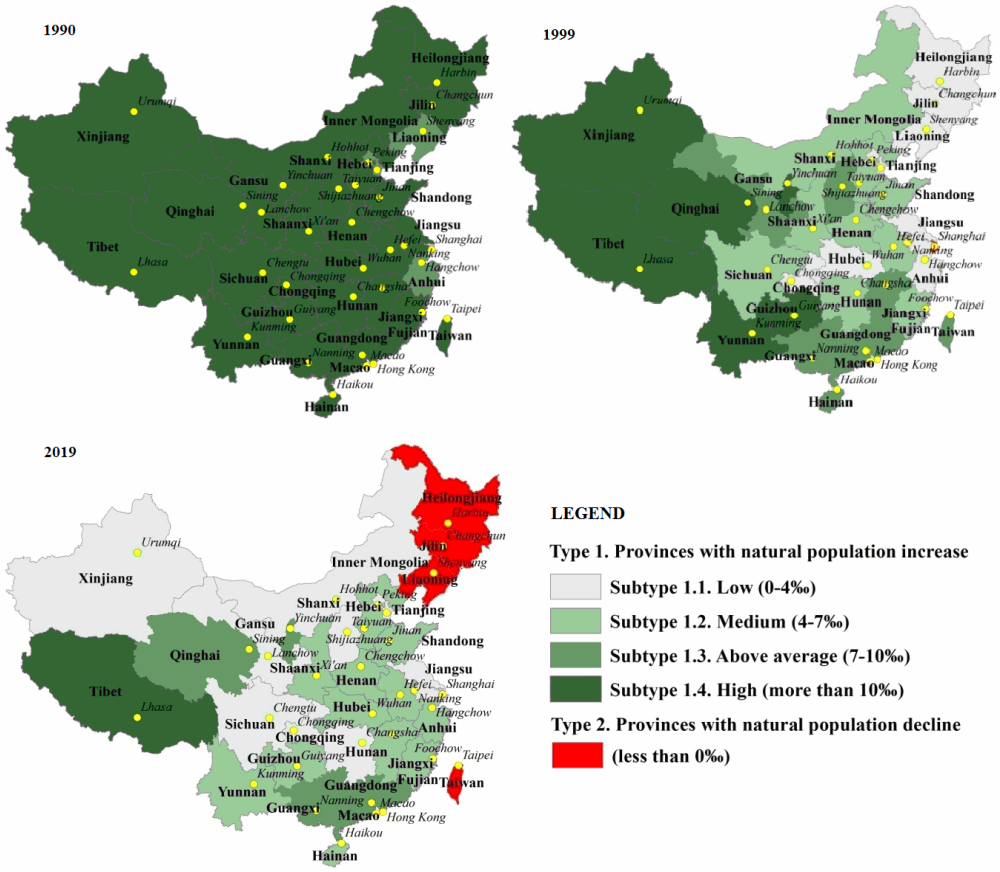

Fig. 4. Typology of the provinces of China based on the character of the natural dynamics of population, 1990-2019.

The number of provinces has sharply decreased and the zone with high values has narrowed exclusively to the western provinces (Fig. 4). However, there was a sharp increase in the number of provinces with low and

average RNI, radically changing the structure of the area. In the east of the country (e.g. provinces of Beijing, Tianjin, Liaoning) and in the centre (Hubei, Chongqing), two zones of low natural increase formed, as well as in central China – a zone of average natural increase. In Shanghai, a natural decline was recorded (1‰). In 2019, we already see the polarization of the area of population natural dynamics in China. Figure 3 clearly distinguishes the zone of natural decline in the northeast (Heilongjiang, Jilin, Liaoning) and Taiwan. The natural increase zone remains dominant, yet changing its character. Provinces with low and average natural increase become predominant, and only in the west and south there are small areas with high or above-average indicators (Tibet, Guangxi, Qinghai, Ningxia, Guangdong). The Chinese government controls the development of population, so the natural decline is a phenomenon in its development. If this scenario develops, it can be predicted that in the next few decades more and more provinces will experience natural population decline, a shortage of labour resources, which will affect regional economic development and ultimately the development of the entire country. Therefore, in 2015, the Chinese government proposed a 'Universality for two children' policy. The goal is to adjust the number of the nascent population and then adjust the age structure.

3.4. Dynamics and spatial pattern of population migration in China

The main feature of the global international migration in the past thirty years has been the intensive growth of its scale. This trend could not but affect the migration processes in China.

China has a large number of young employable people willing to get higher education or a job, and they are actively integrating, thanks to their knowledge and competencies, into the migration space of the world. Over a short historical period from 1992 to 2019, the number of external migrants in China increased tenfold – from 0.8 to 10.7 million people, and the rate of external net migration reached 7.52‰ in 2019, increasing especially rapidly over the past five years (Table 7).

Table 7. Dynamics in the external migration of the China's population.

Year	External migration balance (million people)	External net migration rate (‰)
1992	-0.8	-0.67
2002	-2.0	-1.54
2012	-1.6	-1.15
2019	-10.7	-7.52

Source: compiled by authors based on statistical data from the National Bureau of Statistics of China.

The volume of external migration significantly exceeds the volume of internal migration in the country. According to the data for 2019, the internal net migration rate is more than eight times less than the external one (+1.4‰).

At the same time, there are significant differences in the nature of internal migration in the country, and since 1990 there have been two groups of provinces, the so-called receiving ones – 'acceptors' and giving ones – 'donors'. According to the data for 2019, 'acceptor' provinces with a positive balance of internal migration account for 58.8%, whilst 'donor' provinces with a negative migration balance account for 41.2%.

During the period 1990 -2019, significant changes took place in China's internal migration space under the influence of the regional policy (Qi et al., 2021; Bairoliya and Miller, 2021). In 1990, there was a sufficiently large central zone of provinces with negative migration balance, around which, on a narrow strip in the east, small areas of provinces in the west and in the centre zones of provinces with a positive migration balance were located. In 2019, due to the implementation of the 'Western Development' policy, there was a significant expansion of the zone with a positive migration balance. At present, there are two large areas in it – western-central and southeastern, and an eastern small one. The provinces with the largest surpluses of internal migration are Zhejiang (14.9‰), Xinjiang (11.9‰), Tibet (9.7‰) and Guangdong (7.5‰). The second zone, with a negative balance of migration, has significantly narrowed down to a meridional strip from northeast to south. According to the data for 2019, provinces such as Heilongjiang (-4.8‰), Jilin (-4.1‰), Beijing (-2.9‰) and Hubei (-2.6‰) recorded the largest values of the negative balance of internal migration.

3.5. Demographic balance

China's family planning policy since the 1970s has aimed at achieving balanced population development; to manage the imbalance in the sex ratio at birth means to achieve a balance in the gender structure of the population, and actively respond to the aging processes to achieve a balanced age structure of the population.

After 60 years of population policy implementation, it is clear that the development of China's population has faced many problems that have been researched by scholars. Although these problems manifest in various forms, their essence can be summarized in one sentence: the unbalanced development of the population. Hou Yafei, professor of the Institute of Demographic Research at the Beijing Municipal Party School, believes that the awareness of the low birth rate today does not mean the end of the

population problem, but a transformation of the population problem.

One of the components of the balanced development of the Chinese society is the achievement of demographic balance. In scientific research, the first stage of achieving the demographic balance is to carry out calculations at the level of provinces. This is the first time a study of the demographic balance of China at the level of provinces is being carried out. We took into consideration the experience of Russia and Belarus (Sluka, 2010; Antipova, 2020). The study showed that during this period, from 2010 to 2019, there have been changes, which triggered structural shifts in the dynamics of the size and reproduction of population. Thus, in 2010, two types of balance were distinguished in China – progressive and contrast-factor (Table 8).

Table 8. Typology of the provinces of China by the nature of demographic balance.

Type 1. Progressive (P)	Type 2. Contrast-factor (CF)			Type 3. Regressive (R)
	Subtype 2.1.Contrast-factor based on natural increase (CF_{+N})	Subtype 2.2.Contrast-factor based on migration decline (CF_{-M})	Subtype 2.3. Contrast-factor based on natural decline (CF_{-N})	
2010				
38.2	26.5	35.3	-	-
2019				
Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Guangdong, Hainan, Chongqing, Sichuan, Tibet, Gansu, Qinghai, Ningxia, Xinjiang, Hong Kong, Macao	Shanxi, Inner Mongolia, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangxi, Guizhou, Yunnan, Shaanxi	Beijing	Taiwan	Liaoning, Jilin, Heilongjiang
	32.4	2.9	2.9	
53.0	38.2			8.8

Source: compiled by authors based on statistical data from the National Bureau of Statistics of China.

The share of the progressive type was 38.2%, and, geographically, it was represented by three areas – western, northern and eastern. In 61.8% of provinces, population was formed either due to migration outflow (35.3%) or natural increase (26.5%). This type of balance geographically formed a compact meridional zone from the northeast through central China to the south. In 2019, the spatial view of the demographic balance has undergone radical changes (Fig. 5).

Due to the consequences of population-related policies, a regressive type of balance has formed on the territory of China. This phenomenon can be called a peculiar phenomenon of the country's geodemography. This type is spatially represented by the northeastern zone (Liaoning, Jilin, Heilongjiang). The progressive type makes up 53% of the provinces in the structure, represented by the west-central and eastern zones. As a result of natural decline, the contrast-factor type was supplemented by an independent subtype, which was formed in Taiwan. There has been a significant reduction in provinces ofa contrast-factor type, based on migration loss. As of 2019, only Beijing represents it. At the same time, the number of provinces of the contrast-factor type increased based on natural increase. This type of balance has now geographically formed a compact meridional zone from the north through central China to the south.

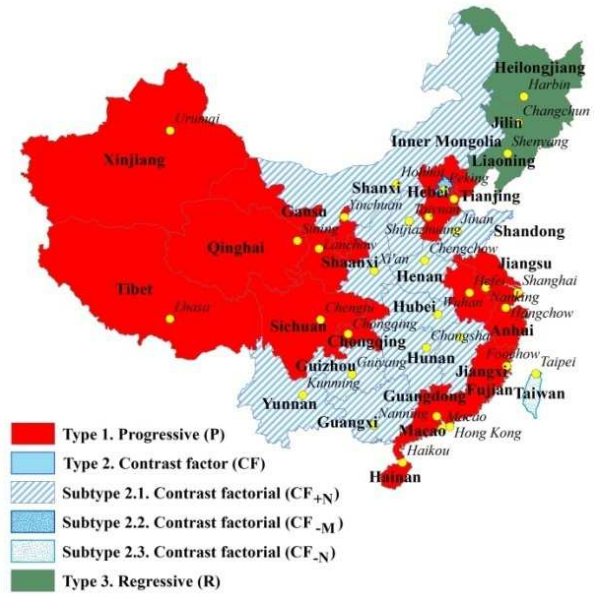

Fig. 5. Typology of the provinces by the nature of demographic balance, 2019 *(source: compiled by authors based on statistical data from the National Bureau of Statistics of China).*

Overall, the national demographic and economic policy of China has radically changed the modern demographic space of the country and is leading to further serious consequences.

Firstly, the labour force is greatly reduced. China's development in the past few decades has mainly relied on its large population, significant number and relatively cheap labour force. However, once the population is reduced, it will lead to a shortage of labour. If there is not enough labour, companies will reduce production, resulting in waste of resources. Maybe there were branches in 10 regions before, but now they can only shut down some of them due to insufficient workforce. The reduction of labour force is also not conducive to China's urbanization construction, because urbanization construction cannot be done without manpower and material resources.

Secondly, there are changes in consumption structure. The impact on the consumption structure is mainly consumer goods in daily life, such as clothing, food, education, medical care. The scale of these industries is mainly determined by the consumer market. If population decreases, the consumer market will also be greatly reduced. These industries need to be scaled down. After the scale becomes smaller, if one wants to achieve better development, one can only improve the service quality or product quality.

Thirdly, there are changes in the social production structure. Population has decreased, but it is necessary to ensure that productivity can keep up. Therefore, automated production will be vigorously developed, low-end work types will be reduced, and low-end industries will even be abandoned. As the number of labourers decreases, working hours will also be shortened. At the same time, labour will be concentrated in scientific research, management, and public welfare. If the development of automation can keep up with the development of society, then the society develops faster, and if the development of automation cannot keep up with the speed of social development, then it may hinder the development of society.

Fourthly, the aging problem is intensified. If the birth rate of the population decreases, then the proportion of the elderly will become larger and larger, which will lead to an imbalance in the population structure. The increase in the proportion of elderly population will naturally lead to the gradual emergence of pension problems. It is necessary to know that the retirement annuity is the social security paid by the young people. If the number of elderly increases, the pressure on the young people to pay social security will increase. In the future, a young person may need to support two elderly people, and the young person's living burden will be heavier.

Fifthly, national tax revenue decreases. Tax revenue created by young people will be reduced and the income of various local policies will also decline, while the increase in the number of elderly will require more investments. Local governments have less revenue, but their expenditures have increased. As a result, the pressure on local governments will also increase greatly. Therefore, in order to avoid population decline and the emergence of population aging, the country will gradually implement policies such as liberalizing family planning and delaying the retirement age.

4. CONCLUSIONS

The conducted study of the geodemographic features of China's development in the period 1990-2019, using GIS technologies, indicates radical qualitative transformations in the trends and nature of the main demographic processes – fertility, mortality, natural and migration dynamics, which occurred under the influence of a number of factors, the fundamental one being the state policy of birth control and family planning, implemented in modern history.

The main demographic trends of China at macrogeographic level, which are phenomenal, at the end of the 20th and beginning of the 21st centuries, show a sharp decline in the birth rate and their compliance with the level of economically developed countries; a decrease in the mortality of the population followed by an increase as a result of demographic aging, and a decrease in the natural growth. These trends were previously absent in the demographic history of the country and were not determined by the demographic policy factors. When the analysis was switched to the microgeographic level – the level of provinces – an increase in spatial heterogeneity was revealed, consisting in both differentiation and polarization of the demographic processes, which is a qualitatively new spatial trend for China in the 21st century. The differentiation is represented by significant differences between provinces regarding population natural dynamics and the manifestation of spatial zoning, depending on the level of influence of the family planning policy factor. Polarization consists in identifying the types of provinces in China by the character of natural dynamics with multidirectional trends – positive and negative dynamics, natural increase and natural decline. At the same time, the dominant types still retain the types of provinces with positive demographic trends, while their share in the structure of the country is weakening. The increasing differences in the spatial and regional demographic development of China has led to the formation of three types of demographic balance – the dominant progressive, contrast-factor and regressive – which is also a phenomenon that requires detailed monitoring while maintaining negative trends. The revealed spatial heterogeneity of China's geodemography in the 21st century, including various trends in the dynamics of urban and rural population, should be the object of more in-depth research and be associated with the need to solve population problems through regional and

mutual cooperation. The study of demographic balance in dynamics and in the context of the provinces of China, developed for the first time, indicates on the one hand, an increase in spatial differentiation, which confirms the first hypothesis of the study, and is a reflection of the actions of the state demographic and regional economic policy, which confirms the second hypothesis. Regions and cities should define key programs and learn from each other's strengths regarding population issues in order to improve the effectiveness of regional population policy implementation.

The current state policy 'Universality for two children', which is being implemented by the country, has created a favourable environment for population growth. At the same time, consideration must be given to whether urban development can withstand the economic changes caused by population growth. The consequences of China's national demographic and economic policy, reflected in the radical shifts in the demographic space of the country, should serve as a scientific justification for further research on the development of geographically differentiated regional policy measures.

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