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Future shrinking cities on the globe: A projection map for 2020–2100 based on global gridded population dataset

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Abstract

Shrinking cities have become increasingly prevalent worldwide due to various factors, which pose serious challenges to affected areas in terms of population decline, economic decline, and spatial deterioration. While existing research studies have focused on identifying shrinking cities, there is a need for global projections to mitigate uncertainties in their growth trajectories. Spatially explicit population grids offer a new approach to identifying potentially shrinking cities with sufficient spatial resolution. By utilizing a global gridded population dataset from 2020 to 2100 under the SSP2 (Middle of the Road) scenario, we produce a global projection map for future shrinking cities. Among the total 19,024 natural cities, 9682 cities (50.9%) will face population decline and 1751 cities (9.2%) may lose more than half population by 2100. Cities in East Asia and East Europe may face serious population decline.

Keywords

Shrinking city, future projection, natural city, population grid

Introduction

As a crucial aspect of UN Sustainable Development Goals (SDGs), Sustainable Cities and Communities (SCC) have earned attention globally and faced several new challenges. Among these, a key aspect is the growth of shrinking cities (SCs) caused by globalization, de-industrialization, suburbanization, and population aging (Pallagst, 2009; Martinez-Fernandez et al., 2012). Looking ahead, many countries, especially those with low fertility and immigration rates, will experience a

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decrease in their total population and urban labor force (UNDESA, 2022). This worldwide phenomenon challenges the ubiquitous growth-oriented planning paradigm globally and has led to several socioeconomic problems that cannot be disregarded.

Existing articles, including case studies and satellite image-based studies, have demonstrated and identified the widespread prevalence of SCs mostly based on the present and past datasets in both developed and developing countries (Guan et al., 2021; Zhai et al., 2022). Future predictions are also mostly focused on certain countries, rather than at a global scale. As a specific manifestation of the country's population decline, urban shrinkage will pose serious challenges to low fertility countries, especially in East Asia and Eastern Europe. Consequently, there is a pressing need to predict SCs on a global scale for demonstrating the urban population decline and providing a prospective outlook to support decision making.

Spatially explicit population grids propose a new approach to address these gaps and support urban studies in identifying potential shrinking cities by offering a descriptive outlook that aligns with the forecasts of other fields (Wang et al., 2022). In this figure, we utilized a global gridded population projection dataset (GPPD) released by previous studies based on the shared socioeconomic pathways (SSPs) to predict the distribution of potential SCs for 2020–2100 under SSP2 (Middle of the Road) scenario (Wang et al., 2022).

Here are the details for obtaining this map. First, we utilize natural city (NC) boundaries to facilitate comparisons among different countries, which are defined as agglomerated areas of more than 5 km^2 construction land (Jiang et al., 2020; Meng et al., 2021). We analyze population change based on the perspective of 2020, and urban sprawl is not taken into consideration. NC boundaries and the GPPD are both calculated based on the public dataset from Chen et al. (2020), which ensures that these two datasets are mutually matched. Second, we choose the SSP2 scenario, a historically based development trend, as our perspective to predict the future SC distribution. SSP2 scenario is consistent with the observed

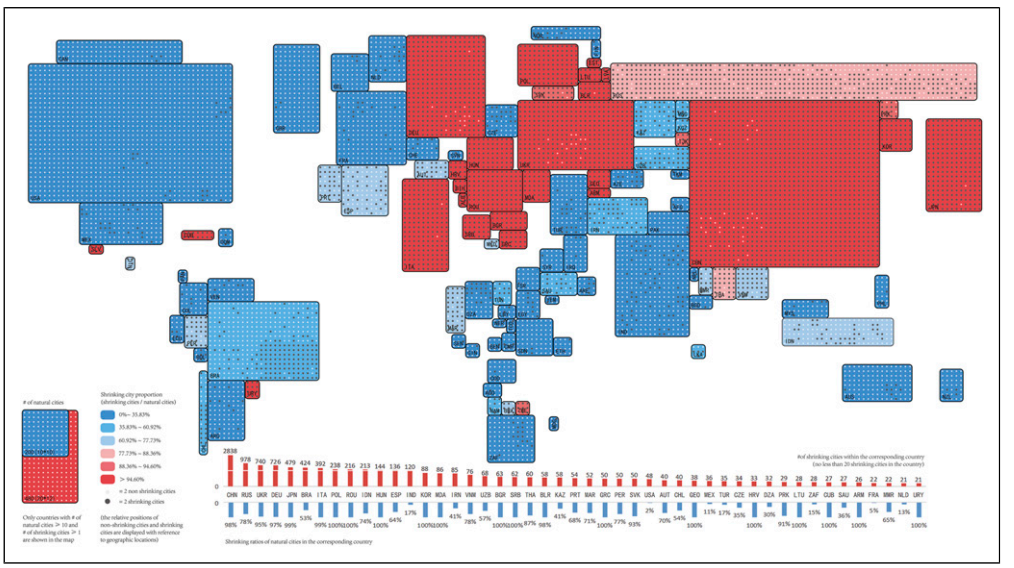

Figure 1. Flat cartogram of 2020–2100 shrinking cities (SCs) on the globe at the country level. The countries (104) shown on this map are countries with a number of natural cities ≥10 and number of SCs ≥1. The legends are the same as the cartogram from Meng et al. (2021). The positions of countries and their SCs are based on their geographic locations. The bottom graphs show the number of countries (47) with >20 SCs and the ratios of SCs.

growth patterns and covers the middle ground of future trajectories between extreme scenarios, like SSP1 and SSP3 (Fricko et al., 2017). Compared with other SSP scenarios, SSP2 represents a plausible and relatively central pathway, which makes it a useful benchmark scenario for assessing the potential impacts. NC boundaries and SSP2 GPPD are utilized for calculating cities' population change rates between 2020 and 2100. Third, we use the legend from Meng et al. (2021) (ensure that the annual average change rate remains unchanged) to illustrate results and conduct a comparison between 2000–2019 and 2020–2100 to show the potential development of world SCs.

Figure 1 is a global flat cartogram map showing the result. Of the total 19,024 natural cities, 9682 cities (50.9%) will experience population decline and 1751 cities (9.2%) may lose more than half of their population in the future. The distribution of SCs is more polarized than in 2000–2019. Compared with historical research, East Europe and East Asia will still be the concentrated areas of SCs, but North America, with potential total population growth, may not experience serious urban shrinkage. It is surprising that 29 countries may suffer significant urban population shrinkage and have more than 90% SCs, such as China, Ukraine, Germany, Japan, and Italy. Low fertility rates and population aging are the characteristics of these countries in the future according to the prediction from the World Population Prospects 2022 (UNDESA, 2022). More detailed information is illustrated at the bottom of Figure 1. With the probability of losing more than 500 million people, China will have the most SCs in the future. Based on the ratio of SCs, Poland, Romania, Hungary, Korea, Moldova, Bulgaria, Serbia, Greece, Georgia, Croatia, Lithuania, Cuba, Armenia, and Uruguay will face urban shrinkage across their whole territories.

Software

ArcGIS 10.8 software is utilized to calculate NC boundaries and identify SCs globally. A flat cartogram is produced by using Adobe Photoshop CC 2018 and Illustrator 2020 manually.

Sources of data

Global gridded population dataset in 2020 and 2100 under SSP2 can be open accessed at https://doi.org/10.6084/m9.figshare.19608594.v2.

NC boundaries in 2020 can be accessed at https://doi.pangaea.de/10.1594/PANGAEA.905890 or http://www.geosimulation.cn/GlobalSSPsUrbanProduct.html.

Declaration of conflicting interests

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