

Sustainable City Development Measurement Based on Gridded Inclusive Wealth —— a comparison between Japan and China

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1. Introduction

In view of the increasing complexity of city problems, Inclusive Wealth (IW) has been used to measure urban sustainability due to its comprehensiveness. The whole city is usually regarded as a single assessment unit in such researches. However, the distribution of IW and the three capitals of IW, human capital (HC), produced capital (PC) and natural capital (NC) are significantly different between urban centers and the suburb areas. To explore the capital connection between urban centers and their surrounding suburbs and its change could help us understand the urbanization mechanism and make better decisions on sustainable city design and urban planning.

With the proper geographical technologies and ancillary data, the gridded IW data can be created for the analysis of spatial distribution. However, it is tricky to create comparable gridded IW maps between two years because of the nonconsistency of the ancillary geographical data.

To address the two issues above, this research first created comparable gridded IW data for the year of 2010 and 2017 by a series of examination and calibration on the original ancillary data. Then we took China and Japan as examples to analyze the difference in the urbanization process between developed and developing countries.

2. Data and Methodology

For HC, we first calculated the per capita HC for each city in China and Japan in 2010 and 2017. Then we obtained the gridded population data from WorldPop and adjusted them to make sure that the sum of gridded population within a city is equal to the corresponding number reported by the statistical bureau. Finally, we multiplied per capita HC with the adjusted gridded population and got the gridded HC data.

For PC, we assume that produced capital has a positive linear relationship with the nighttime luminosity in urban areas. Because the nighttime light data of 2010 and 2017 come from different satellites, we performed a cross-sensor calibration to make them comparable. The PC wealth at the city level was disaggregated to each grid in proportion to the digital number of each pixel in the calibrated nighttime light imageries.

For NC, we followed the method of non-timber valuation in Inclusive Wealth Report 2018 to

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estimate the wealth of renewable resources. For the non-renewable resources, we allocated the national wealth of each resource to where they deposit according to their distribution maps.

3 . Results

The IW density of China increases by 67.4% from 13.2 in 2010 to 22.2 million USD/km² in 2017. The IW density of Japan only increased by 6.8% from 133.8 to 142.1 million USD/km².

For the 345 cities in China, all the cities experience an increase in HC. PC increases fastest especially for the western cities in Xinjiang and Tibet. Only few cities in middle China are enjoying an increase in NC. For Japan, HC in major cities like Tokyo are increasing, while many rural cities are suffering a serious depopulation problem. What is interesting is that most of those cities with declining HC have an increasing manufacturing capital. Most NC-declining cities appears in metropolitan areas.

Fig.1 shows the IW growth patterns in two biggest cities of each country. The IW distributions in Tokyo and Osaka don't change much, but there is a clear increase in Beijing and Shanghai.

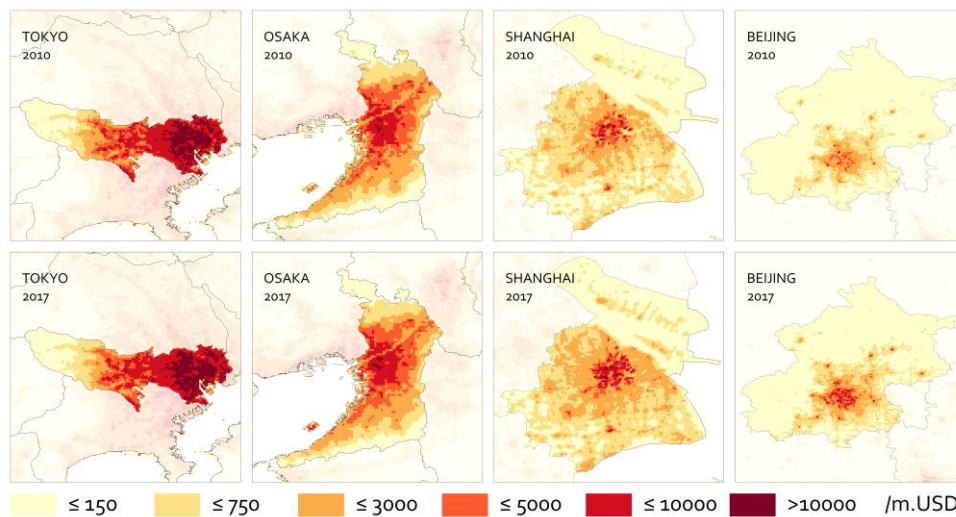


Fig.1 Gridded inclusive wealth change in metropolises from 2010 to 2017

4 . Conclusion

Rather than the gridded IW calculation for a single year, this research shows the change of IW between 2010 and 2017, which indicates regional sustainability. The results of this study well reveal the difference between developed and developing regions in terms of human, manufactural and environmental aspects. HC and PC are increasing at the cost of natural resources, and PC increases fastest in developing countries; in developed countries, the depopulation in rural areas exacerbates the inequality of HC distribution, NC increases possibly because of the improvement of people's environmental consciousness. Wealth expansion from urban centers to its surroundings is obvious in cities which are in the process of rapid urbanization, but the IW distribution changes little overtime in developed cities.