Spatiotemporal Evaluation of Comprehensive Carrying Capacity: A Case Study Focusing on Sustainable Development of Guangdong–Hong Kong–Macao Greater Bay Area, China.

January 2021

Fei LIU

Spatiotemporal Evaluation of Comprehensive Carrying Capacity: A Case Study Focusing on Sustainable Development of Guangdong–Hong Kong–Macao Greater Bay Area, China.

A Dissertation Submitted to
the Graduate School of Life and Environmental Sciences,
the University of Tsukuba
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy in Science
(Doctoral Program in Geoenvironmental Sciences)

Fei LIU

Abstract

The vigorous growth of demands on carrying capacity caused by urban sprawl has been a crushing burden for the urban environment. Exceeding the carrying capacity in urban growth has given rise to massive negative impacts on the urban environment. The carrying capacity evaluation framework is used to estimate whether reserves of natural assets are adequate for sustainably maintaining human development. Thus, the evaluation of carrying capacity is perceived as a barometer for diagnosing sustainability (Wei et al., 2015). Carrying capacities can be useful tools for optimal allocation of resources and urban services, as well as interpreting the interactions between human activities, land resources, and urban environments.

With a vast land area, dense population, abundant natural resources, and advanced economic growth, the Guangdong–Hong Kong–Macao Greater Bay Area (GBA) is the most prominent urban agglomeration in China's development blueprint (State Council, 2019). As one of the primary pioneering regions in China's urbanization, unchecked economic growth and uncoordinated sustainability efforts have emerged in GBA due to large-scale urban sprawl of various cities over a long time period. According to national plans and policies, the urban agglomeration of GBA is expected to forge as a paragon of high-quality development (State Council, 18 February 2019). In light of this, ecological construction and coordinated regional development in the urban agglomeration of GBA call for a synthetic, scientific evaluation of the regional sustainability status.

Against this backdrop, the main goal of this study was to evaluate the spatiotemporal evolution and variations of the regional sustainability in the urban agglomeration of GBA based on regional comprehensive carrying capacity between 2000 and 2015.

First, the spatiotemporal pattern and differentiation of land resource pressure in GBA were investigated by considering population aggregation, the level of land development, and land suitability for urban construction. Next, the spatiotemporal pattern and variations of the ecological footprint and biocapacity in GBA were measured using multi-source data. The ecological status of the GBA was spatially evaluated at different scales. Finally, the regional comprehensive carrying capacity for the urban agglomeration

of GBA between 2000 and 2015 were assessed, based on multi-criteria decision analysis, in terms of social development, economic capital, environmental resources, transportation and communication. The equilibrium state for regional development in GBA was determined based on synthetic regional supporting and pressuring characteristics.

The results show that the spatial variations in land development pressure noticeably increased in GBA from 2000 to 2015. The efficiency of urban land utilization in GBA can be improved by avoiding unplanned urbanization and by preventing encroachment into ecological space.

Owing to the increased ecological capital that humans require, and declining ecological reserves, the gap between the supply and demand within the urban agglomeration of GBA has aggravated since 2000. The magnitude of ecological unsustainability in GBA has expanded further. During 2000 to 2015, the majority of increments in the ecological deficit and pressure in GBA were spatially concentrated in cities with dense populations, highly urbanized areas, and critical resources, such as Shenzhen, Hong Kong, Guangzhou, Dongguan, Macao, and Foshan. The allocation and construction of ecological functional areas should be implemented based on the characteristics of the GBA cities and the spatial heterogeneity of ecological assets.

The comprehensive carrying capacity in GBA exhibited an upward trend from 2000 to 2015, which indicates that the comprehensive regional sustainability relatively improved in these 15 years. The carrying capacities of the resource environment and transportation were dominant contributors. Noteworthily, when comparing the performances of various carrying capacity indices, there were salient spatial gradients and differences across cities of GBA. This indicates that the uneven and diverse sustainability in the cities of GBA cannot be neglected. The load-bearing balance of sustainability between cities was determined based on the various supporting and pressuring abilities of the 38 carrying capacity indicators of the comprehensive carrying capacity of the GBA. The inequality and imbalance between supporting and pressuring carrying capacity in GBA have been exacerbated between 2000 to 2015. Overloaded cities clustered in the central and coastal parts of GBA, while the remaining cities were still loadable.

The development of Hong Kong and Macao has been extremely unsustainable due to the imbalance between supply and demand of land resources. Only by accelerating the integration of Hong Kong and Macao into GBA, sharing land resources, and increasing

carrying capacity, can coordinated development be realized. The carrying capacity, resources, and distinct superiority of cities in GBA can complement and influence each other. Collectively, these strengths can become the core driving forces behind future sustainable development of the GBA.

The synthetic evaluation of regional carrying capacity can guide regional coordinated development in GBA. This should focus on deepening regional collaboration and integration with consideration for environmental governance and ecological regulation. This would expand the cooperation area, optimize resource distribution, and achieve complementary results.

Keywords: Comprehensive Carrying Capacity, Ecological Regulation,
Guangdong–Hong Kong–Macao Greater Bay Area, Sustainable Development