

Chinese urbanization 2050—system dynamic modeling and process simulation

June 19 2017

Chinese urbanization has profoundly contributed to the whole country's economic growth, social advancement and life improvement. Parallel to this process, however, China has confronted a series of problems, such as loss of agricultural land, reduction in biodiversity, unaffordable urban housing, problematic transportation, uneven regional economic development, and other issues.

Despite these difficulties, China continues toward urbanization, but in a new mode. The Chinese New Urbanization plan is the central task for China to completely recognize a well-developed society by 2020. Nevertheless, two critical yet unsolved questions that decisively influence China's urbanization agenda still persist: What is the highest stable urbanization level that China can reach? When can China complete its urbanization? In fact, these two questions have already been widely studied. But due to each study's inherent limitation, there are prominent differences or even contradictions among these existing research conclusions, which resulted in policymakers' struggling to decide which conclusion should be set as the foundation for formulating China's New Urbanization plans.

To tackle this challenge, a Chinese research team has recently proposed a multi-dimensional system dynamic (SD) simulation [model](#) of Chinese urbanization from the perspective of complexity. This model enables users to examine the complex process of Chinese urbanization from a dynamic perspective. Through robust model verification and validation against historical data, this model, compared with the existing ones

proposed by other scholars, has much higher reliability, credibility and practicality. Through this model the policy makers can generate more scientific policies and development schemes for China's New Urbanization towards 2050.

A paper explaining the details of the model and its application has been published recently in *SCIENCE CHINA Earth Sciences* by principal investigator Prof. Gu Chaolin from the School of Architecture, Tsinghua University and collaborators. The research team successfully applied the SD modeling approach to understand the Chinese urbanization process. It not only gives details of China's urbanization mechanism constrained by environmental sustainability in a comprehensive view, but also its representation in full mathematical expression. In addition, the research proposes an SD modeling framework customized to China's New Urbanization (Figure 1) that specifies the model's mathematical logic, the structure of the subsystems for SD modeling and the modeling techniques for simulating the interactions among these subsystems. With robust model validation, the paper finally presents the ultimate urbanization levels China can achieve in multiple scenarios.

The research team suggests that there are three key challenges in parallel with the application of SD modeling to Chinese urbanization. The first is to quantify the underlying urbanization mechanism with high accuracy; the second is to justify the model's validity with convincing evidence in the context of China. And the last is to insure the flexibility of the model's applicability so that it can support urbanization policymaking scientifically. In the modeling process, the causal-loop diagrams of the subsystems that represent each dimension of the mechanism are assembled into stock and flow diagrams, including main factors and subsystems such as industries, population, cities and towns, education, etc. (Figure 1). Then, supported by packages including DYNAMO, iThink, Vensim and Powersim, the theorized Chinese urbanization process is modeled using the SD methodology. The conformity of the

model is validated against the historical data from 1998 to 2013 while the model's stability and degree of confidence are justified by a differential equation approach. To increase the model's applicability, two critical elements including GDP growth rate and family planning policy fundamentally concerned in China's New Normal era are considered. With combinations of different values of these two parameters, the ultimate [urbanization](#) level and the year in which it can be achieved in a series of scenarios are simulated and explained.

The conclusions should provide all the tiers of government in China reliable evidence for policymaking and policy implementation throughout the process of China's New Urbanization.

More information: ChaoLin Gu et al, Chinese urbanization 2050: SD modeling and process simulation, *Science China Earth Sciences* (2017).
[DOI: 10.1007/s11430-016-9022-2](https://doi.org/10.1007/s11430-016-9022-2)

Provided by Science China Press

Citation: Chinese urbanization 2050—system dynamic modeling and process simulation (2017, June 19) retrieved 7 August 2024 from <https://phys.org/news/2017-06-chinese-urbanization-2050system-dynamic-simulation.html>

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