**Measuring urban sustainability through the co-evolution of unified socio-environmental structures**

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The paper illustrates how to measure the sustainable urban system characteristics from the case study of Chinese prefecture cities. As of 2015, there were 657 cities in China, including four municipalities directly under the central government, 293 prefecture-level cities, and 360 county-level cities. However, comprehensive fine-scale city statistical data in China are only available at prefecture-level. In addition, there are many autonomous prefectures and leagues in western and northern China. Although they are administratively equivalent to the prefecture-level cities in eastern China, they have low urbanization rates, less developed economies and industries, and sparse population density. They lack statistical data appropriate for measuring urban sustainability. Thus, they are excluded from the case study. As a result, the final dataset includes 278 prefecture-level cities, including 251 in 2000, 267 in 2005, 276 in 2010, and 278 in 2017. The list and explanations of the constructs and measured variables are reported the following table.

*The list and explanations of measured variables****\****

|  |  |  |  |
| --- | --- | --- | --- |
| Dimension | Variable | Meaning | Calculation method |
| ECO | gdp | Gross domestic product | - |
| gdp\_p | GDP per capita | GDP/Population |
| wage | Wage | - |
| PAT | invg\_a\_p | Invention patent applications per capita | Invention patent applications/Population |
| umg\_a\_p | Utility mode patent applications per capita | Utility mode patent applications/Population |
| desg\_a\_p | Design mode patent applications per capita | Design mode patent applications/Population |
| inva\_e\_p | Invention patents authorized per capita | Invention patents authorized/Population |
| uma\_e\_p | Utility mode patents authorized per capita | Utility mode patents authorized/Population |
| desa\_e\_p | Design mode patents authorized per capita | Design mode patents authorized/Population |
| INFOR | tele\_in\_p | Telecom business volume per capita | Telecom business volume/Population |
| mobile\_p | Mobile phone per capita | Mobile phone users/Population |
| inter\_p | Internet users per capita | Internet users/Population |
| SOR | crop\_g | GDP per unit area of crop land | GDP/Area of crop land |
| forest\_g | GDP per unit area of forest land | GDP/Area of forest land |
| water\_g | GDP per unit area of water land | GDP/Area of water land |
| CP | no\_g | GDP per unit NOx emission | GDP/NOx emission |
| so\_g | GDP per unit sulfur dioxide emission | GDP/Sulfur dioxide emission |
| dust\_g | GDP per unit discharge of industrial dusts | GDP/industrial dust discharge |
| EDU | college\_p | Colleges per capita | Colleges/Population |
| college\_t\_p | Proportion of college teachers per capita | college teachers/Population |
| college\_s\_p | Proportion of college students per capita | college students/Population |
| TRANS | road\_p | Road area per capita | Road areas/Population |
| bus\_p | Bus per capita | Buses/Population |
| taxi\_p | Taxi per capita | Taxies/Population |

***\**** *Patent data is mainly derived from the patent cloud website (*[*https://app.patentcloud.com/*](https://app.patentcloud.com/)*)., land use data is mainly from the land use database of the Chinese Academy of Sciences (*[*http://www.resdc.cn/data.aspx?DATAID=184*](http://www.resdc.cn/data.aspx?DATAID=184)*), and other data are mainly from the Online China Urban Statistics Yearbook (*[*https://data.cnki.net/yearbook/Single/N2020050229*](https://data.cnki.net/yearbook/Single/N2020050229)*).*