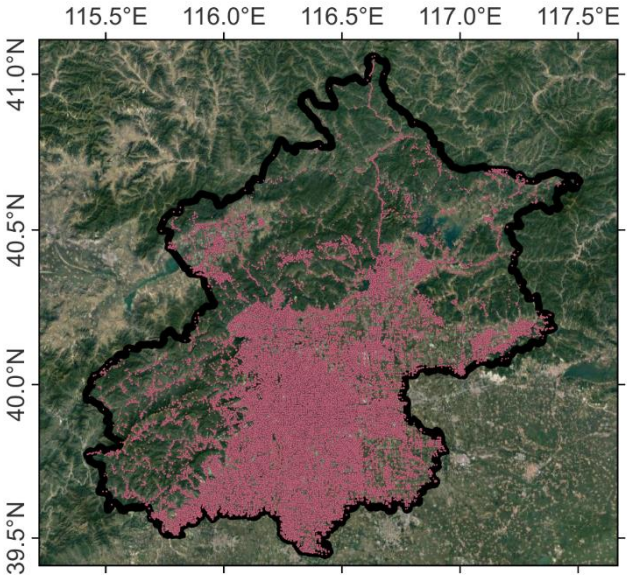

Figure S1. Road nodes of Beijing. These nodes represent intersections of the Beijing roads.

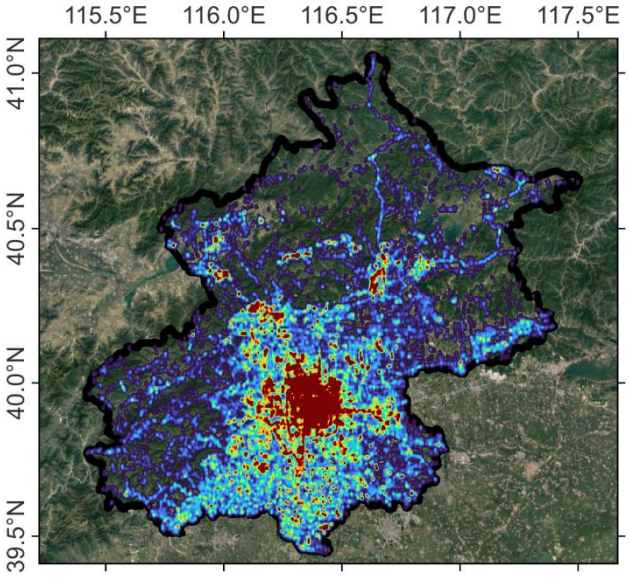

Figure S2. Kernel density map calculated by road nodes in Beijing. The redder the color in the figure, the denser the road nodes; the bluer the color, the sparser the road nodes. 1000m is taken as the bandwidth of kernel density estimation, and 100m is taken as the map unit.

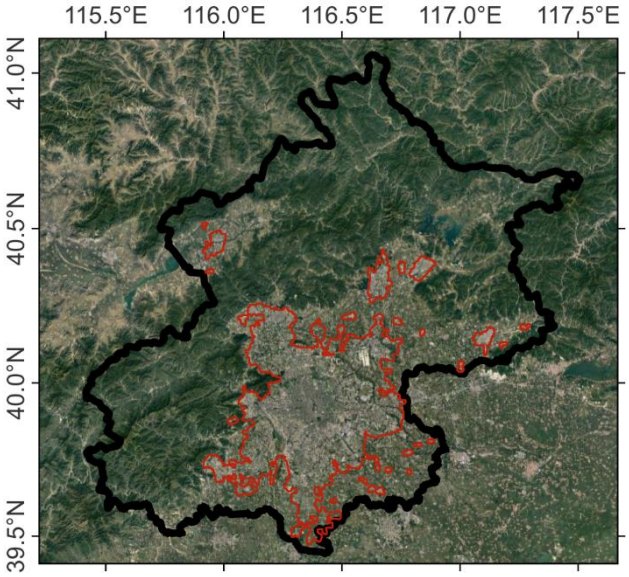

Figure S3. Initial urban boundary of Beijing. The target raster is calculated by multiplying the normalized nighttime light data and the normalized kernel density map. After that, threshold method and morphological processing are applied to obtain the initial urban boundary. Finally, patches with an area smaller than 2 km^2 are filtered.

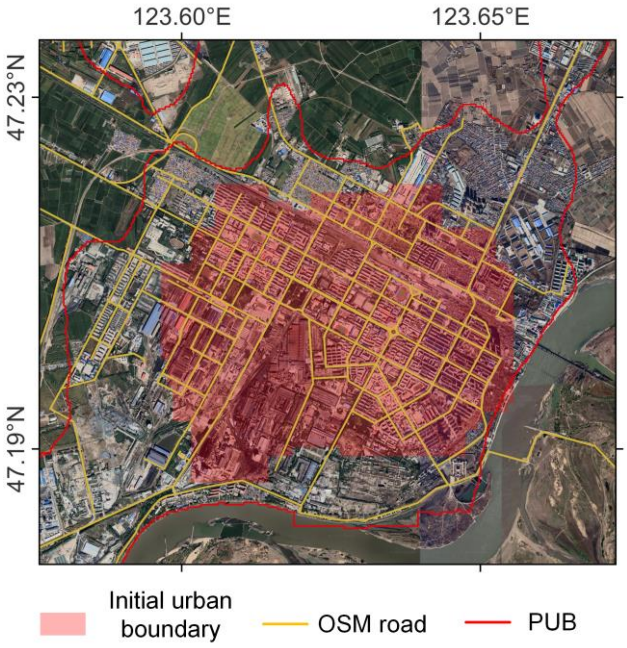

Figure S4. Initial urban boundaries, OSM roads, and PUBs for a part of Qiqihar City. The buildings in this area are dense. However, the initial urban boundary significantly underestimates the real urban boundary. Incompletely updated road data and subjective threshold method are the main reasons for this phenomenon.

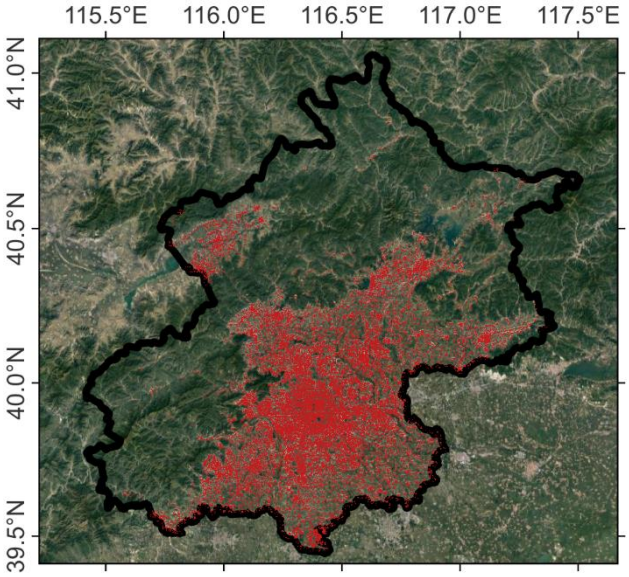

Figure S5. Impervious surface of Beijing. The impervious surface dataset is produced by a multi-level classification approach that combines temporal similarity, spectral features, and logical reasoning. This approach mainly incorporates dynamic time warping for time series classification, which can effectively extract impervious surface.

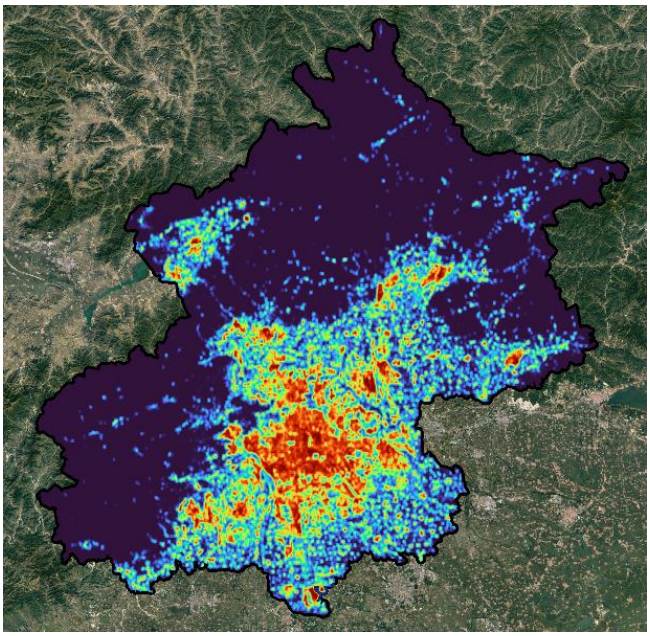

Figure S6. Impervious surface density map of Beijing. The redder the color, the greater the density, and the maximum value is 1.

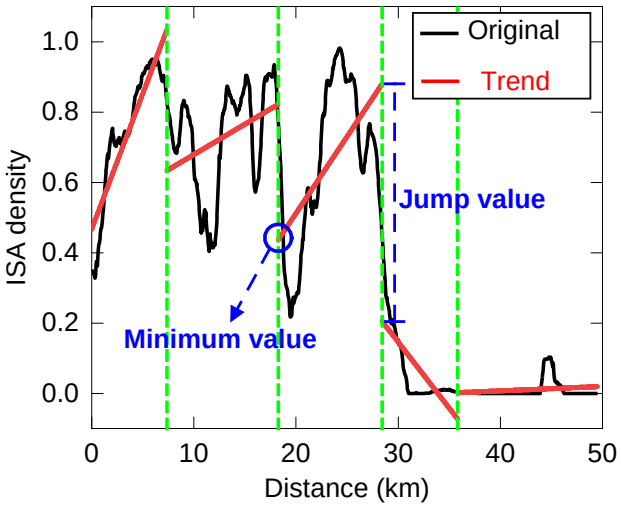

Figure S7. The impervious surface density series sampled by a sampling line in Beijing and its features after BFAST detection. If the jump value (the current value of the mutation point subtracts from the next value) is positive, it may change from urban to rural areas; if it is negative, it may change from rural areas to urban areas. The minimum value is used to determine whether the current sub-series represents a rural area or an urban area.

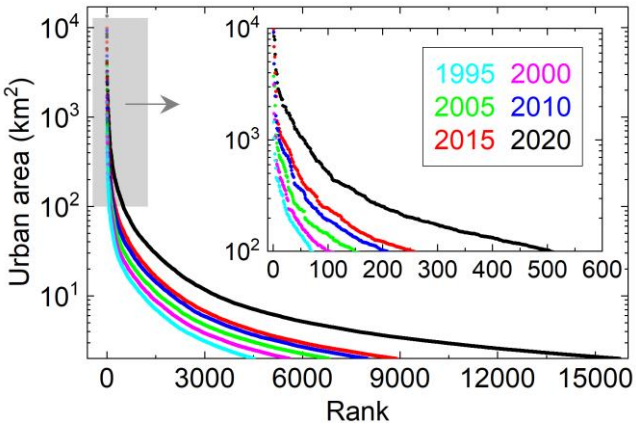

Figure S8. The size-rank relationship of GUB Chinese cities (an area greater than 2 km^2) from 1995 to 2020.

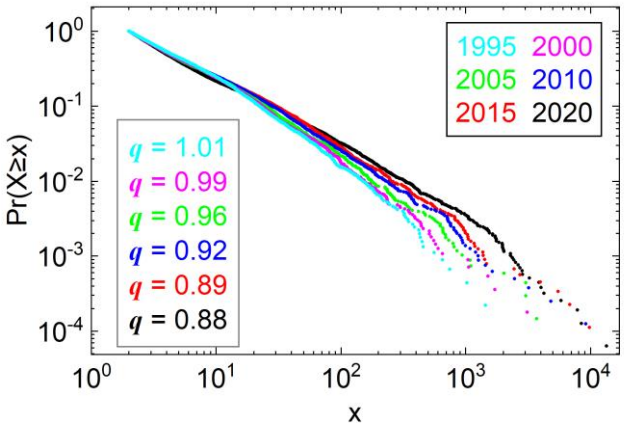

Figure S9. Distribution of Zipf's in GUB Chinese cities from 1995 to 2020.

Table S1. The list of provinces where the urban agglomeration is located.

Short name	Urban agglomeration	Province list
BTH	Beijing-Tianjin-Hebei region	Beijing, Tianjin, Hebei
YRD	Yangtze River Delta	Shanghai, Jiangsu, Zhejiang, Anhui
GBA	Guangdong-Hong Kong-Macao Greater Bay Area	Guangdong, Hong Kong, Macao
TNP	Three northeastern provinces	Liaoning, Jilin, Heilongjiang
SPUA	Shandong Peninsula Urban Agglomeration	Shandong
TCC	Triangle of Central China	Hubei, Hunan. Jiangxi
CCCG	Chengdu-Chongqing City Group	Chengdu, Chongqing
GPCG	Guanzhong plain city group	Shaanxi, Shanxi, Gansu
CPUA	Central Plains Urban Agglomeration	Henan

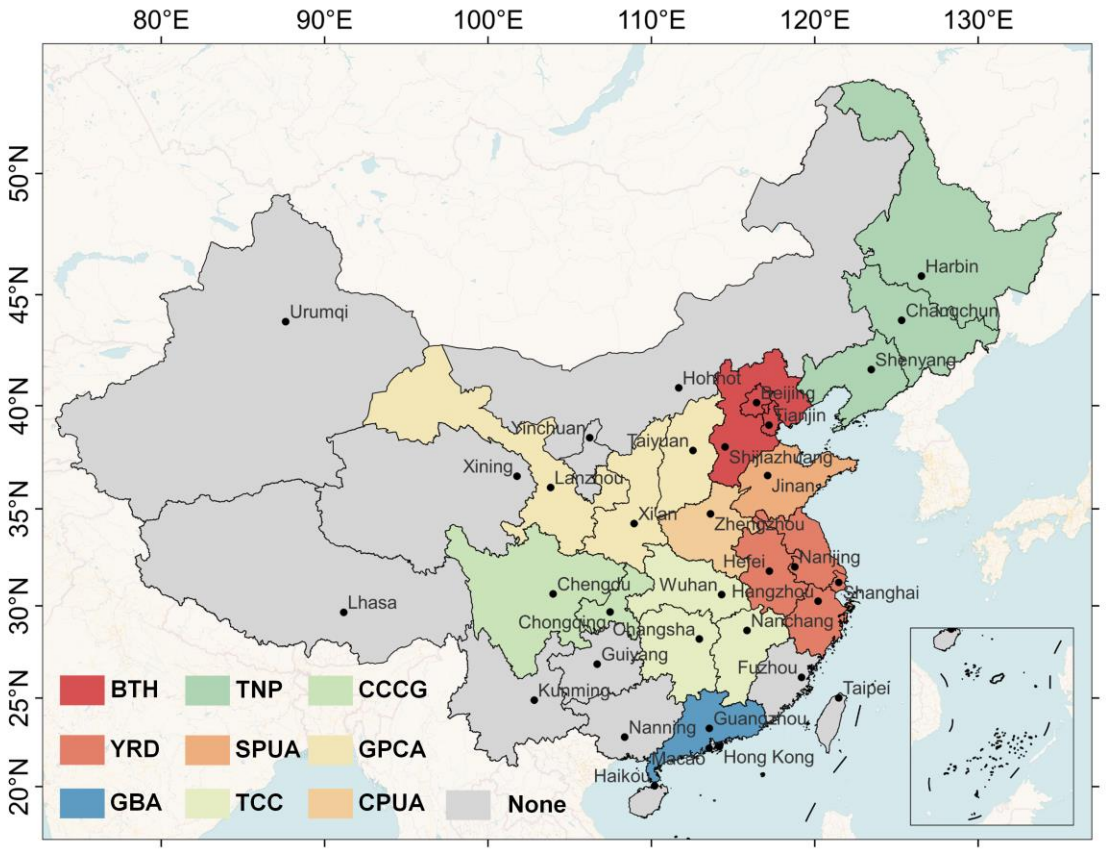

Figure S10. The distribution of provinces where China's urban agglomerations are located, and the locations of major cities.

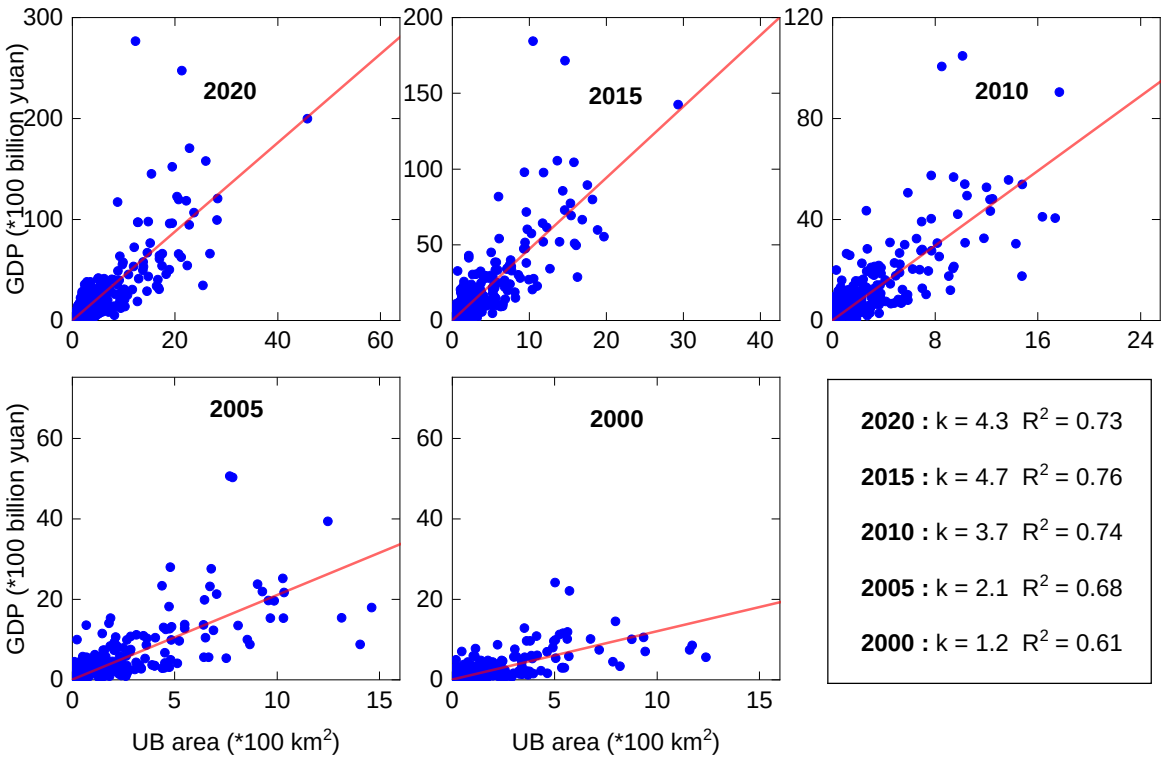

Figure S11. Scatter distribution of urban area and GDP at the city level and its fitting line (red line).

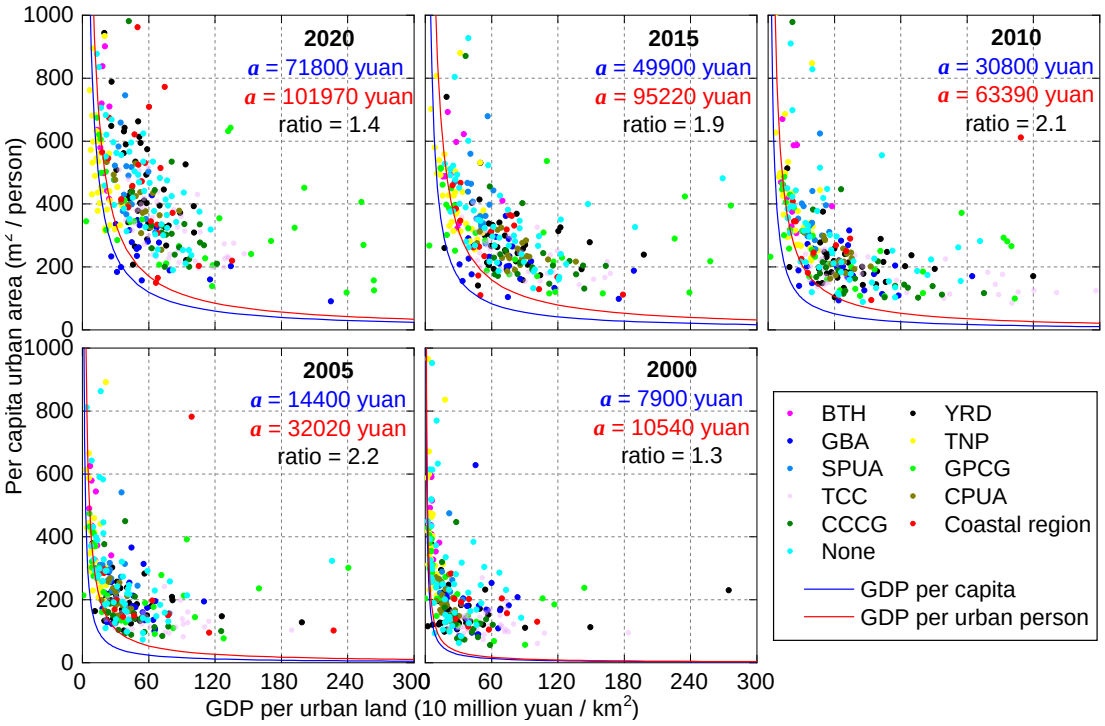

Figure S12. Distribution of urban intensification in each city of China (blue line: national per capita GDP; red line: city-level average per urban capita GDP).