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What morphology affects the air pollution in a larger scale of urban agglomeration areas? An evolving perspective from 2-D urban form to 3-D socio-economic form based on satellite imagery and machine learning

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The researches on the influence of urban form on air pollution have gradually become a hot topic. Studies show that more compact and continuous cities correspond to more environment-friendly land use patterns and traffic layout. But as the name suggests, this kind of morphological index is only for urban area definitively, for example, based on the precise boundary of the built-up area. However, returning to the mechanism of urban morphology affecting air pollution, all kinds of social and economic factors that have capacity of pollution discharge or traffic flow impact are the basis of pollution, no matter whether they are distributed in urban or non-urban area. In large-scale urban cluster area, traffic flow does not only exist within a city, but also generate between cites like metropolises,satellite cities, peripheral small or medium-sized cities and even some important towns. In another hand, some air pollutants have been proven to have long-distance transmission characteristics across the city. Based on the above three points, we can see that on the basis of the studies on the relationship between urban morphology and air pollution, it is necessary to further explore the relationship between the spatial patterns of socio-economic factors concentrated area (SFCA) and air pollution, taking closely-linked urban clusters in large regional scales as a whole.

In this paper, we obtain the information about the regional socio-economic intensity based on the night-time remote sensing data, the distribution information of socio-economic elements based on the Baidu LBS big data and the fine spatial structure as well as the stable time series data based on Google high-resolution historical remote sensing images. Through the spatial clustering and deep learning method, we identified the closely-linked urban cluster areas, extracted the boundaries of the SFCAs, and further calculated the morphological index of highly socio-economic factors concentrated area (HSFCA) and the low socio-economic factors concentrated area (LSFCA).In this process, we obtained the POI data of industrial and mining enterprises in 2015 using Baidu LBS platform, and got the information of China's industrial and mining enterprises distribution. Taking it as label data, more than 450 thousands of 60m-resolution Google remote sensing images were trained by VGG convolution neural network. The result was used to predict the social and economic three-dimensional distribution map of China from 2001 to 2010 through the trained network and Google historical images.

Furthermore we establish Air pollution-SFCA morphology panel model during 2001 to 2010 in China. The results showed that the stronger air pollution is linked to the larger edge density of SFCA, the more complexity of shape and the higher degree of aggregation. Greater the dispersion degree of H-SFCA and L-SFCA respecively result in stronger the air pollution. With a greater the degree of the aggregation of different SFCA types, air pollution is likely more weaker. The results can provide an environmental protection proposal for the planning of social production layout in futural urban agglomerations around world.