Spatial estimation of municipal household wastes by integrating multiple geographical big data and social survey

Xiaoqian Liu
College of Applied Arts and Science of Beijing Union University
Beitucheng West street No.197, Haidian District, 100191
Beijing, China
liuxq@lreis.ac.cn

Bin Meng
College of Applied Arts and Science of Beijing Union University
Beitucheng West street No.197, Haidian District, 100191
Beijing, China
mengbin@buu.edu.cn

Juan Wang
College of Applied Arts and Science of Beijing Union University
Beitucheng West street No.197, Haidian District, 100191
Beijing, China
juanwang@buu.edu.cn

Tao Pei
Institute of Geographical Sciences and Natural Resource
Datun Road West, No.11, Chaoyang District, 100101
Beijing, China
peit@lreis.ac.cn

Abstract

China had set up a number of garbage classification pilot cities since 2000, combining with multiple environmental regulations, however the overall effect is less efficient, resulting in great waste of resources, causing a set of urban environmental problems. The bottleneck is that, on the one hand, lacking of precise estimation of the amount of recyclable household waste, as a result of the mismatch of classification facilities and the classification method are not feasible; on the other hand, lacking of spatial estimation of waste, thus hardly make targeted urban management measures. The study proposed a precise spatial estimation method for different typical municipal solid wastes by integrating geographical big data and local resident's preference survey. The study take one of the typical community in Beijing city as an example, to testify and apply the method, on both an accurate assessment of the amount and spatial locations of municipal waste, thus could provide scientific supports for further optimization of waste recycling and municipal managements.
Keywords: Spatial estimation, geographical big data, household waste, waste classification

1 Introduction

The research aims to precisely spatial estimation method for different typical municipal solid wastes by integrating geographical big data and local survey method.

Current research are mostly based on the annual statistical data, calculate the city as one unit, the household waste as output, and while the residents' consumption as input. Thus, with lower time and spatial sensitive, estimation are mostly given on city level annually. While, waste were produced in a bottom up way, residents recycling preference and their classification behaviour are crucial in the process. Besides, lacking of spatial estimation of waste, hardly support targeted urban management measures.

2 Data

In this study, geo-bit data would be coupled with traditional social survey data, to produce high time sensitivity(daily, work day and weekend) and high spatial accuracy(on social community level) estimation of household waste. Mobile phone data (Beijing city, two days in 2015, 20,000,000) and point of interest (POI) dataset (all locations points in the study area, more than 5000) would be used.

Geographical big data offers the possibility of an accurate estimation of the amount of trash and a study of the classification of urban residents based on spatial attributes. In this study, geo-data has the following advantages: (1) The spatial and temporal scale, resolution and observation dimension of geographical big data are improved both in micro and macro aspects; (2) A revolutionary breakthrough has been made in the observation of people, behaviours and social phenomena; (3) The expansion of sample size, coverage and sample density has challenged traditional geography and statistics.

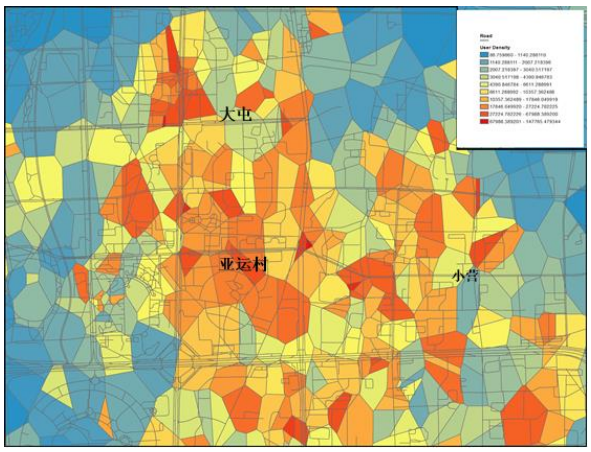
3 Method

In this study, we proposed a method to spatially estimation of the municipal waste by integrating the multi-source geographic big data and the traditional social geography survey method.

3.1 Accurate estimation of populaton density of each location

As the household waste were directly connected how many and where the urban residents lived, and their waste deposal and recycling behavior. Thus, to estimate the number and density of urban population, we utilized the mobile phone big data, which could be used to infer the geographical characteristics of the urban residents. Figure as followed.

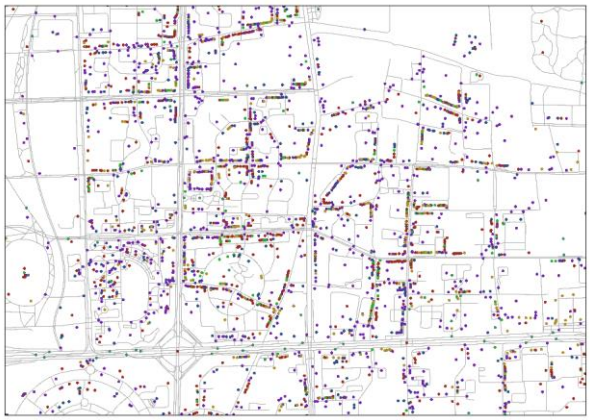
Figure 1: population density estimation based on mobile phone data in 2015 in the research area.



3.2 Household waste estimation on different POI attributes

POI attributes were used to classify the spatial units, especially for specify the major trash structure of the people in this location. Combining other big data based on the spatial location, such as the public comment network on food and beverage sites, the spatial attributes of the locations can be identified.

Figure 2: Distribution of different types of points of interest (POI)



After this, method for estimation different kind of household waste on certain kind of location could be generated as followed. Per capita municipal waste *j* amount in location *i* , calculation equation as follows:

$$T_{ij}^{day} = \bar{t}_{cj} \times I_{ij} \times r_{ij} \times \frac{D_i}{D_c} (j = (1,2,3,4), i = (1,2,3,...6)) \quad (1)$$

in which, location *i*, and waste type *j*, t the daily waster for per urban resident, D_c the average population density in the city, r_{ij} the waste reclassifying efficiency for the urban residents in location *i for* waste type *j*, I_{ij} the weight of certain type of waste.

POI point's attributes were used to identify the waste type and structure. For example, restaurants were major source of kitchen waste, while education and research institute were source of paper and package waste, business centre have a more complex waste structure

3.3 Survey of resident's waste classification behavior

Geo-big data were used to provide a more scientific basis for sampling social surveys of urban residents' willingness to classify municipal waste residents survey were designed according to their general waste recycling preference and waste amount of different kinds.

Survey on residents result then were used to combine with spatial big data, to achieve the transformation from gross estimation to accurate classification evaluation, from trend analysis to categorization and spatial planning, so as to provide accurate, quantitative, spatial scientific basis.

4 Result and Discussion

The study provide a bottom up method of household waste calculation, considering the residents living location and their waste consumption behavior on community level. The research will produce a spatial estimation map of different kind of household waste: food, package, bottles, others. Multiple geo-big data were introduced in the study to get high temple and spatial resolution estimation of urban population, and waste consumption behavior. The result proved support of waste classification and recycling policy optimization for urban managers in China.

References

Beigl, P., Lebersorger, S. et al., (2008) Modelling municipal solid waste generation: A review. *Waste management.* 28(1): 200-214.

Hu, J., Wenzhe, L. et al. (2010) Urban Problems and Countermeasures of Kitchen Waste Utilization. *Environmental Science and Management*, 6: 006.

Zhang, D. Q., Tan, S. K., et al. (2010). Municipal solid waste management in China: status, problems and challenges. *Journal of Environmental Management*, 91(8): 1623-1633.

Pei, T. et al. (2015) Uncovering the Directional Heterogeneity of an Aggregated Mobile Phone Network. *Transactions in GIS*, 18: 126-142.