Environmental Benefits of Bike Sharing Based on Limited Trip Data

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Abstract

This study, for the first time, proposes a novel method to estimate the potential environmental benefits realistically via limited trip data, which only consists of the longitude and latitude of start points and end points of bike-sharing trips rather than huge amount of GPS trajectory data of shared bikes, and is supposed to automatically upload position and other information to the data center of bike-sharing companies via satellites. In addition, based on the position information of shared bikes, the routes and route distance travelled by bikes and vehicles can be accurately computed on the correspondent bike-road network and vehicle-road network, which can be obtained by a free open-source map platform: OpenStreetMap. Following this, the potential environmental benefits of bike sharing can be calculated through the route distance travelled by vehicles based on an assumption that people tend to utilize the vehicles if the distance travelled by shared bikes exceeds a certain value of threshold, and such threshold value reflects the inertia of people.

Introduction

- The development of public transportation contributes to mitigation of urban air pollution.
- Bike sharing has received more attentions, particularly on its potential environmental benefits.
- The number of research on the environmental benefits of biking sharing is still very limited, and the existing research not only heavily relies on trajectory data of shared bikes

Contributions

- Propose a novel method to accurately estimate the reductions of carbon dioxide emission caused by use of bike sharing based on limited trip data
- Explore the impacts of heterogeneous inertial behaviors of people on the environmental benefits of bike sharing.

Framework of methodology

Extract the road network via OSM

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Select the road networks for bikes

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Estimate the trajectories of bikes based on shortest path algorithm

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Calculate the distance travelled by bikes

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Filter trajectories potentially travelled by vehicles based on threshold

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Calculate the emission based on IPCC approach

Intergovernmental Panel on Climate Change (IPCC) approach

$$C = Y \times N \times H \times O$$

where C are the CO2 emissions from fossil fuel, Y is the fossil fuel consumption (in physical unit), N is the net calorific value that represents heat released when unit fossil fuel is combusting, H is the carbon content that represents CO2 emit when unit heat is released, and O is the oxygenation that represents oxidization rate of fossil fuel combustion.

Numerical example

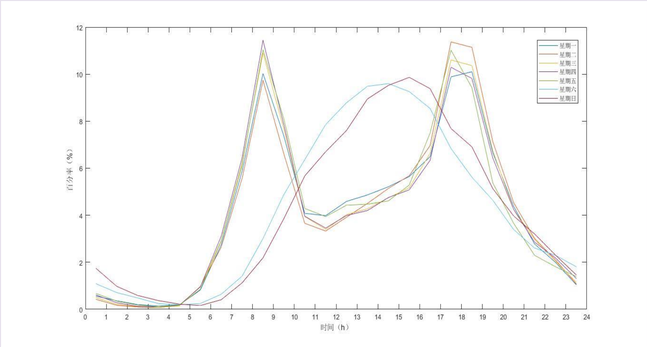

Figure 1 Trips distribution of bike sharing on weekday and weekend in New York

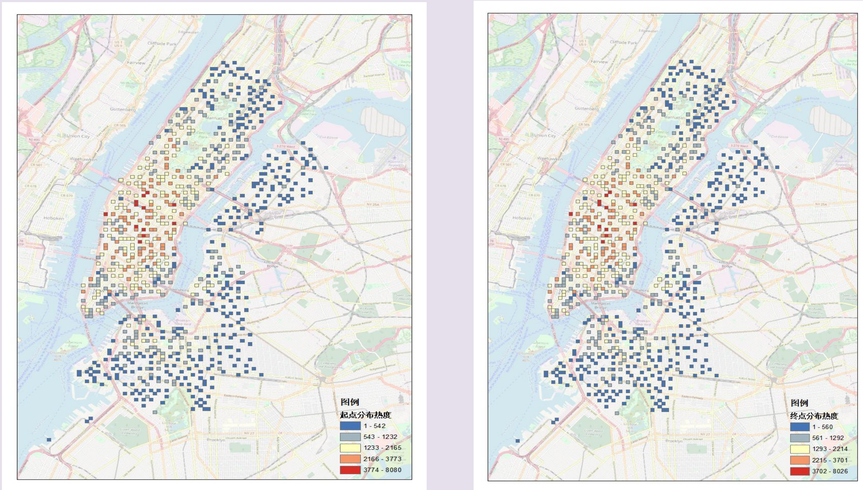

Figure 2 Origin and destination distribution of bike sharing in New York

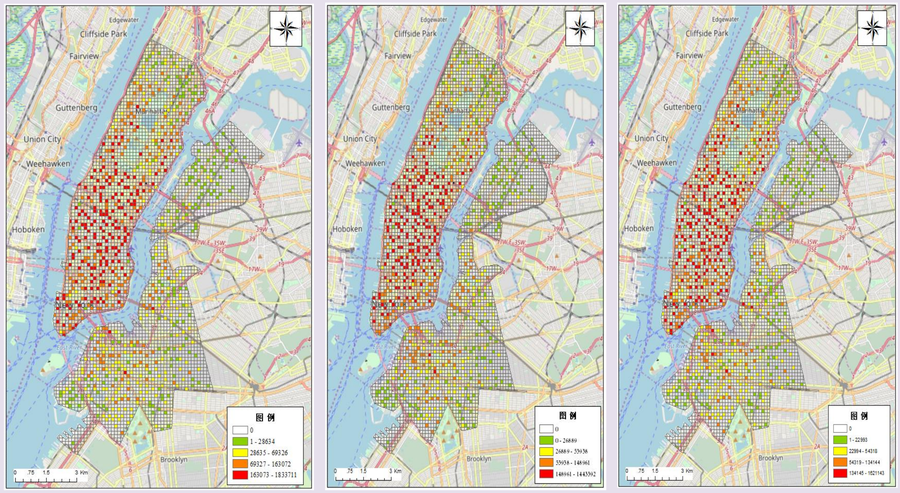

Figure 3 Environment benefit distribution of bike sharing in New York based on 500m, 1000m and 1500m threshold, respectively

Conclusions

- The results suggest that our novel method is able to accurately estimate the environmental benefits of bike sharing based on limited trip data.
- The results suggests that the heterogeneous inertial behaviours of people have significant impacts the environmental benefits of bike sharing.

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