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## Influence of three types of boundary on the level of greenspace in cities

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### Abstract

Greenspace is undoubtedly a main component of urban ecosystems. An urban greenspace system should not only include parks and attached greenspace within the city but should also encompass larger areas of greenspace around the city. However, in megacities that are undergoing rapid urbanization, intense changes in land use and land cover are occurring as large areas of farmland and forest are built up. In urban agglomerations, urban boundaries can extend beyond administrative boundaries; this process can exert a substantial influence on the index of urban greenspace. In contrast, mountains and rivers may effectively act as natural boundaries for the control of urban sprawl. What are the correlations among metropolitan boundaries, natural boundaries, and urban boundaries (called the "three types of boundary") and their influence on the level of greenspace? By analyzing Tokyo, New York, London, Paris, Hong Kong, and Shanghai as cases, this study examines the patterns and interrelations among these three types of boundary. Model analysis results indicated that different models of the three types of boundary gave rise to different levels of greenspace. There are benefits to improving the level of greenspace (1) when metropolitan boundaries exceed urban boundaries; (2) when metropolitan boundaries are consistent with natural boundaries; or (3) when farmland around the city can be incorporated into greenspace and made part of the urban GI, which occurred in London and was presumed to contribute to its high figure for per capita greenspace. Furthermore, it was determined that the current administrative boundaries of Shanghai could be optimized by breaking with the administrative boundaries established in 1958 and redrawing its western boundary to conform to natural boundaries. Optimized metropolitan boundaries can facilitate the establishment of larger areas of greenspace, which can increase per capita greenspace, provide new spaces for development, and enhance international competitiveness.

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## Nomenclature

GI	green infrastructure
NNBA	Near-natural-boundary Advantage
NDN	the nearest distance from urban center to natural boundary
LUCC	landuse and landcover change

## 1. Introduction

Urban flooding, a worldwide natural disaster phenomenon because of extreme weather, is causing hazards to both the population and infrastructure. A catastrophic stormwater and flooding event just happened in Wuhan, China in July 2016 [1], and we should rethink profoundly how to defuse the embarrassment. Urban "resilience" is believed as an effective countermeasure which means an ability to maintain, return, adapt, or transform for desired functions as a boundary object (i.e. malleable adaptability) [2]. The times of "resilience renaissance" is coming [3]. A concept of sponge city is now put into practice in many Chinese cities to embody urban resilience. One indicator is to build more temporarily rainwater-storage greenspace. However, we should pay more attention to green infrastructure (abbr. GI) rather than greenspace because of the limitation of urban greenspace. GI has wider contents including both urban greenspace and surrounding natural and half-natural eco-resources such as forest, grassland, farmland, water and wetland [4]. The diverse eco-resources are key shelters for cities which are open ecological systems and should integrate urban areas with outer broad rural areas.

However, the ongoing urbanization has caused fiercely landuse and landcover change (LUCC) in developing countries [5,6], such as in China where a lot of farmlands, forests, rivers, lakes and wetlands were transformed into built-up areas during the last dozens of years [7]. Greenbelts are favored to control the urban sprawl in world-wide cities such as Shanghai where greenbelt is along the outer-ring road and becomes a very valuable survivor from diverse driving forces [8]. Some other cities (e.g. Tokyo and Hong Kong) take mountains and rivers as natural boundaries to control urban sprawl [9].

Where should be the boundary of a city or city agglomeration during the urban sprawl? During the process of urban agglomeration, urban boundaries can extend beyond administrative boundaries; this process can exert a substantial influence on the index of urban greenspace. Furthermore, metropolises are also beyond administrative boundary during senior urbanization stage so as to be a primary attribute of modern megacity and a basic regional unit of research and statistics over the world [10]. Some metropolises, e.g. London, Paris and Tokyo in developed countries, have been mature and stable stage of urbanization for dozens of years and should provide enlightenments for developing cities.

There are systematic theories on urban spatial organization, such as garden cities, spatial diffusion theory, core-edge model, location theory, new urbanization, and the theory of smart growth. But some other questions are still need to explore, such as: what are the correlations among urban boundaries, metropolitan boundaries, and natural boundaries (called the "three types of boundary") and their influence on the level of local greenspace? We will take London, Paris, New York, Tokyo, Hong Kong and Shanghai as cases to answer the questions. The results will help to find ideal boundary of a metropolis and increase urban resilience.

## 2. Methodology

### 2.1. Study sites

This study adopts analytical method from concept to case analysis. Six international metropolitan are taken as cases to depict the spatial correlations of three types of boundary.

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