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Mapping Urban Population Distribution Based on Remote Sensing and GIS — A Case of Jing'an District, Shanghai

Jiahong Wen, Yating Liang, Dongjing Yao, Yan Yang

Department of Geography, Shanghai Normal University, Shanghai 200234, China

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Outline

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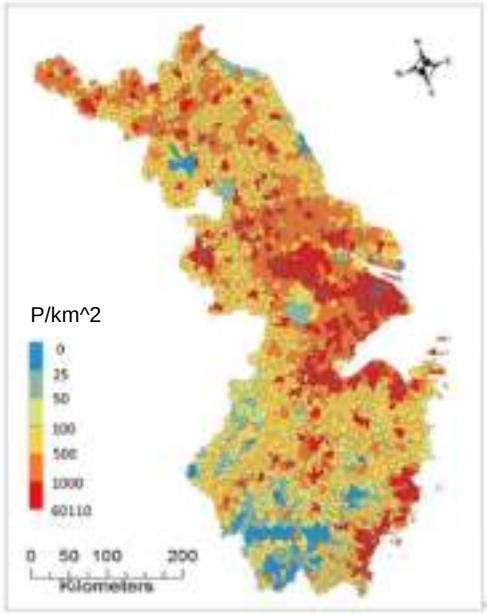
2. Methods and Data sets
3. Land use classification
4. Population distribution simulation
5. Concluding remarks

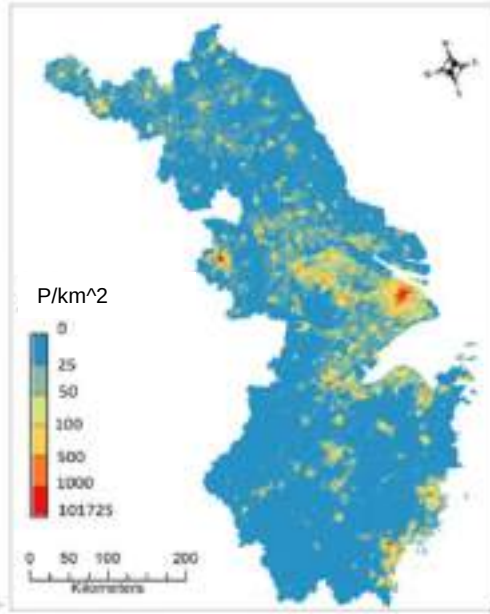
1. Introduction

1.1 Background

- Population is a key element exposed to natural disasters.
- Urban population distribution is very complex and dynamic. It keeps changing with seasons and holidays, between working days and weekends, days and nights.
- Census data can not indicate spatio-temporal population distribution. In contrast, population mapping based on remote sensing and GIS may provided more actual distribution in urban areas.



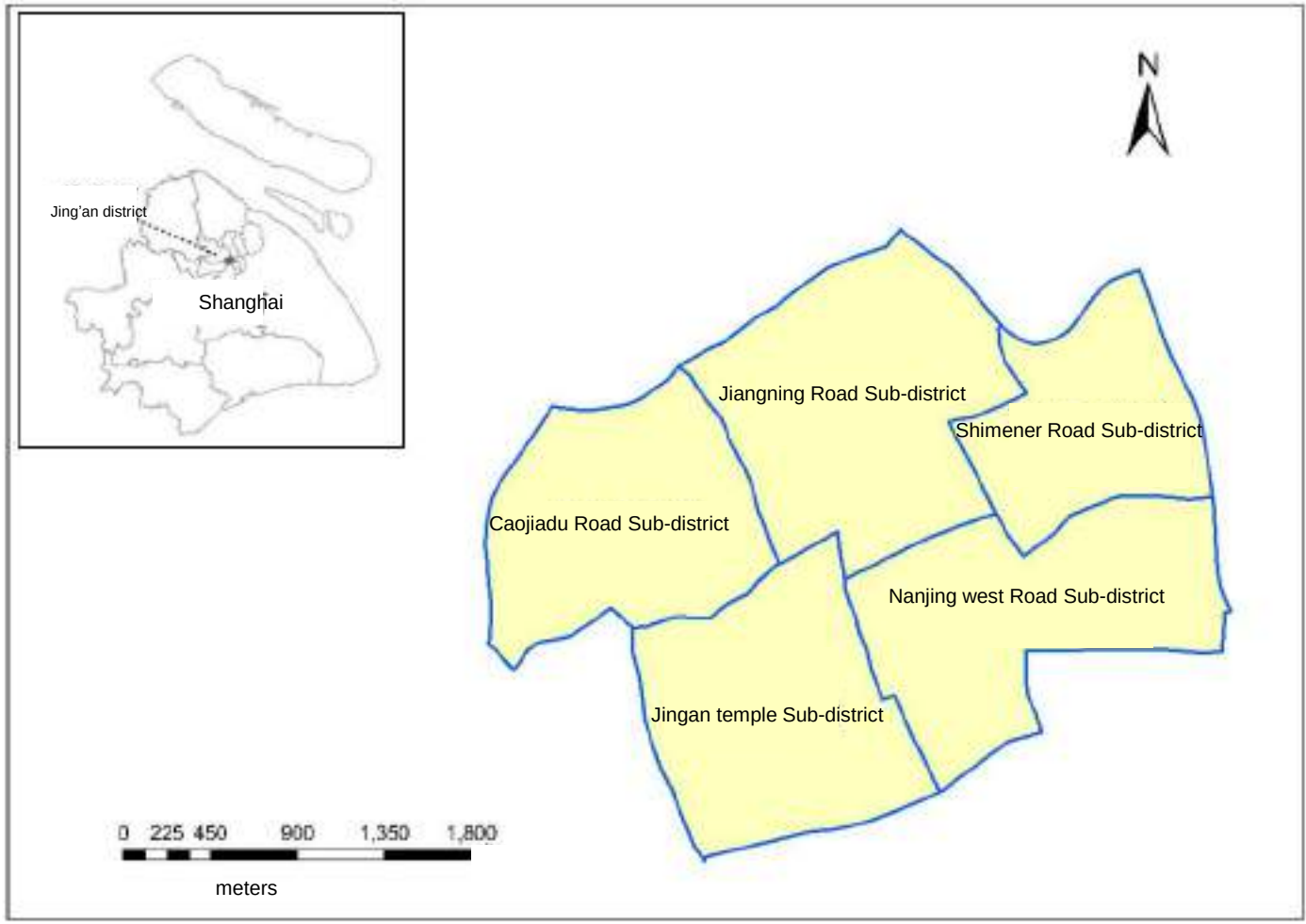
Census map



Gridded pop map

1.2 Study area

- Jing'an District, located at the CBD of Shanghai, has a total area of 7.6 km^2
- 5 sub-districts, and 71 communities.
- The total resident population is about 304 thousand people according to 2010 census.



2.1 Methods

- Population distribution in a working day was mapped, using dasymetric mapping based on land use.
- A detailed land use classification system was developed for mapping urban population distribution, and
- A detailed land-use in the study area was interpreted from high-resolution aerial photographs.

- According to the urban resident activities, we divided a working day into four time periods.
- Several models were used for simulating the spatial distribution of population in the four time periods in our study area.

Time	Behavior	Population concentration places
08:00-12:00	Working hours	residential land, commercial land, industrial land, public management and public service land
12:00-13:00	Midday break	residential land, commercial land, green space and square land
13:00-18:00	Working hours	residential land, commercial land, industrial land, public management and public service land
18:00-08:00	Nighttime	residential land, commercial land, green space and square land

2.2 Data sets

- Aerial photogrphs with resolution of 0.25 m in 2012
- The sixth census data of Shanghai in 2010
- Demographic data from Shanghai Civil Affairs Bureau in 2013
- The second economic census data in 2008
- Shanghai administrative division data, and
- In-situ survey data

3.1 Land use classification system for mapping urban population distribution

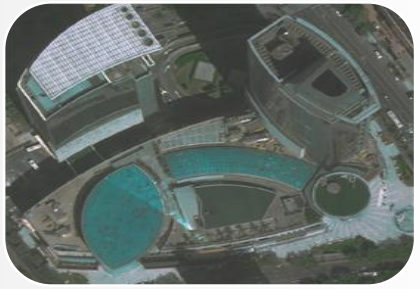
- Referring to the “Standard of Urban Land Use Classification and Land Use of Planning and Construction (GB50137-2012)” in China and the land use classification system from HAZUS, and
- According to the land use characteristics in Shanghai CBD, a land use classification system was proposed for mapping urban population distribution .

Jingan district land use classification system

Category code			Category name/layer name
R	R1		Residential land
		R11	Low-rise residential
		R12	multi-story residential
		R13	mid high-rise residential
		R14	high-rise residential
	R2		mobile housing
	R3		agencies hostels
		R31	student domitory
		R32	amy domitory
		R33	prision
	R4		community welfare homes
	R5		commercial mixed housing
	R6		other mixed-residential
B	B1		commercial facilities
		B11	retail business
		B12	wholesale market
		B13	catering
		B14	hotel
		B15	shopping Centre
	B2		business facilities
		B21	finance and insurance
		B22	arts and media
		B23	other business facilities
	B3		entertainment, leisure and sports facilities
		B31	entertainment
A	A1		public management and public service
			administrative Office
		A11	general Administrative Office
		A12	emergency response agencies
	A2		cultural facilities
		A21	book and exhibition facilities
		A22	cultural activities and other facilities
	A3		education and research
		A31	inst of higher learning ,secondary schools
		A32	primary and secondary schools
		A33	school physical education
		A34	special education
		A35	scientific research
	A4		physicalp
		A41	sports venues
		A42	sports training
	A5		medical and health
		A51	hospital
		A52	health and epidemic prevention
		A53	special medical
		A54	other medical and health
	A6		cultural relics and historic sites
	A7		foreign Affairs
	A8		religious facilities
	A9		mixed public services
G	G1		green
	G2		square
	G3		other land use
E			waters

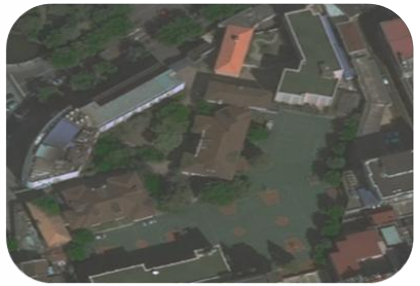
3.2 Principles and methods of urban land use classification

Residential land



Commercial land

Industrial land



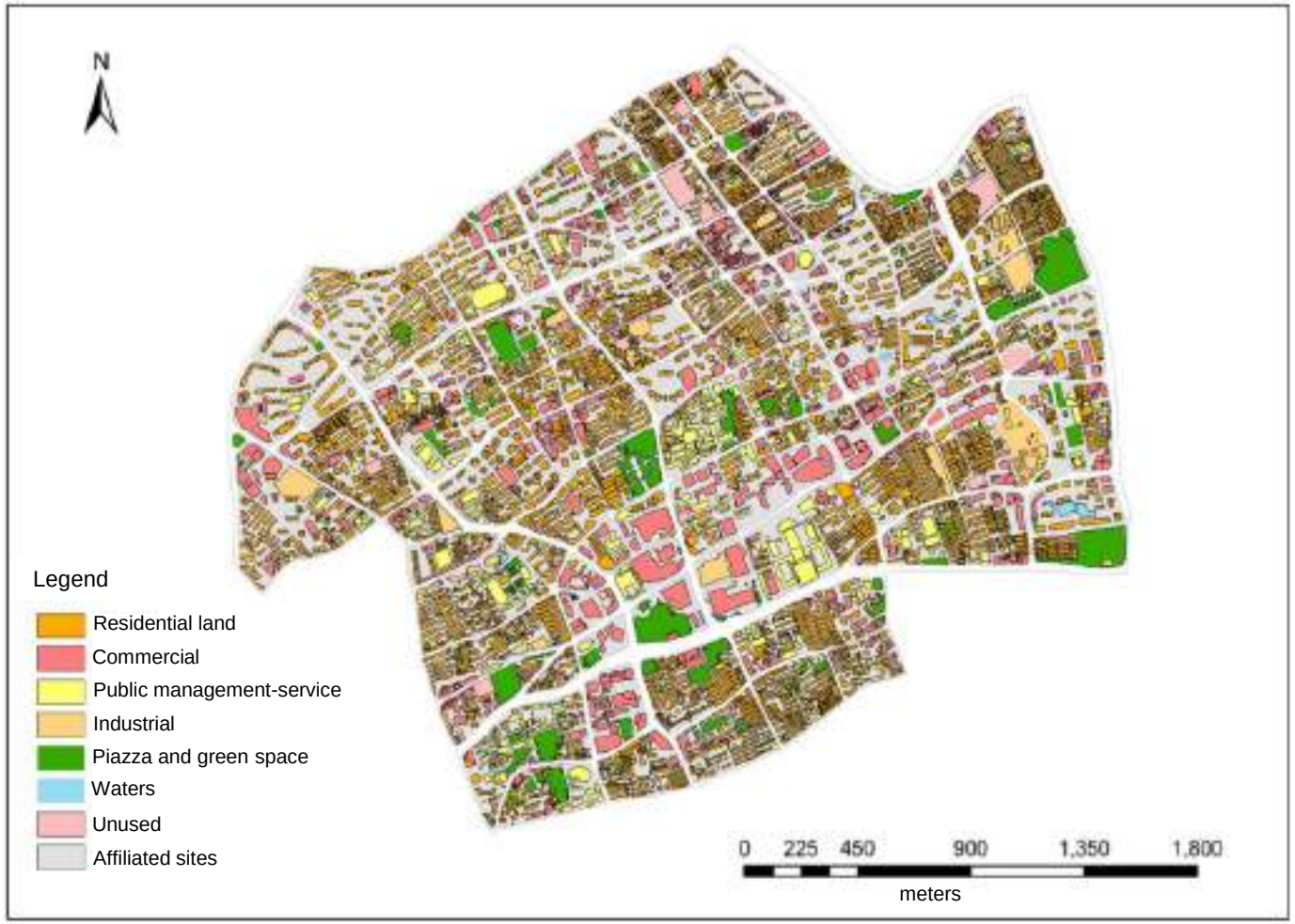
Public management and public service land

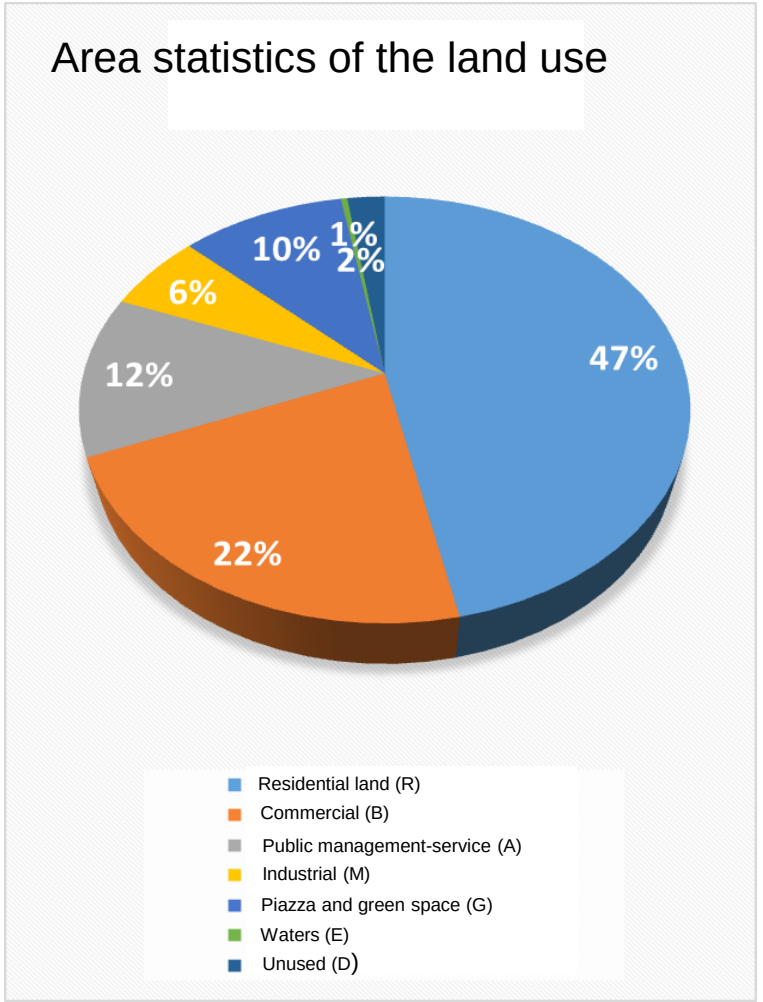
Green space and square land

Water land

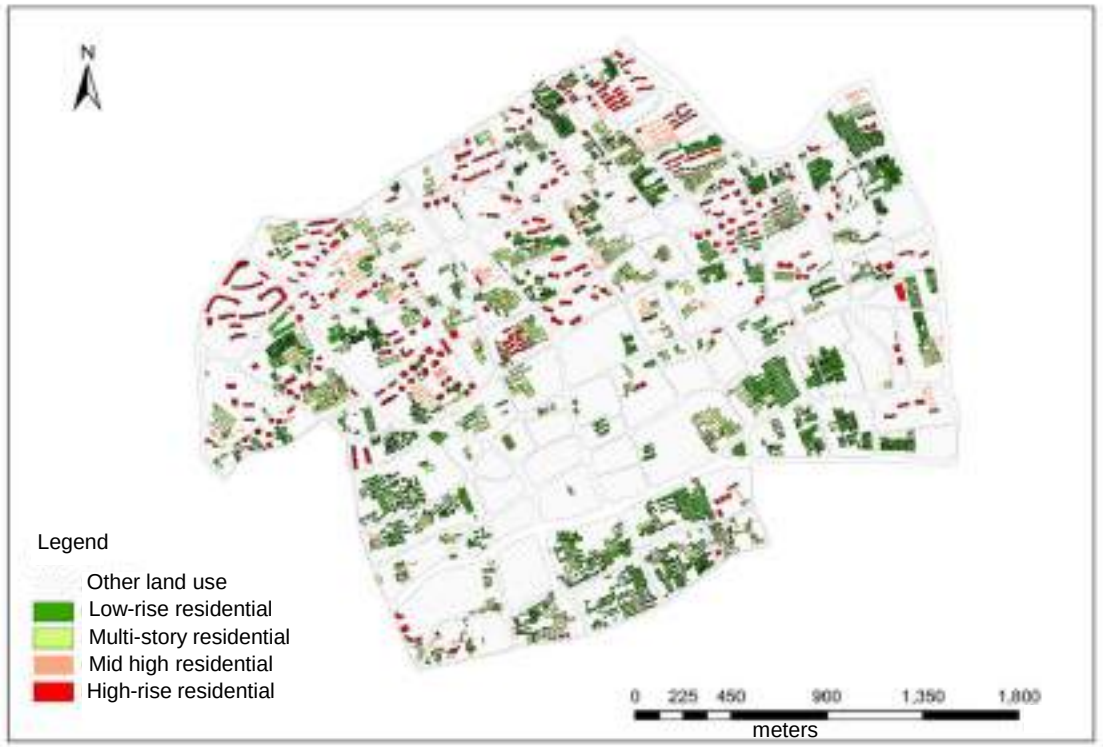
Unutilized land

3.3 Land use in Jing'an District



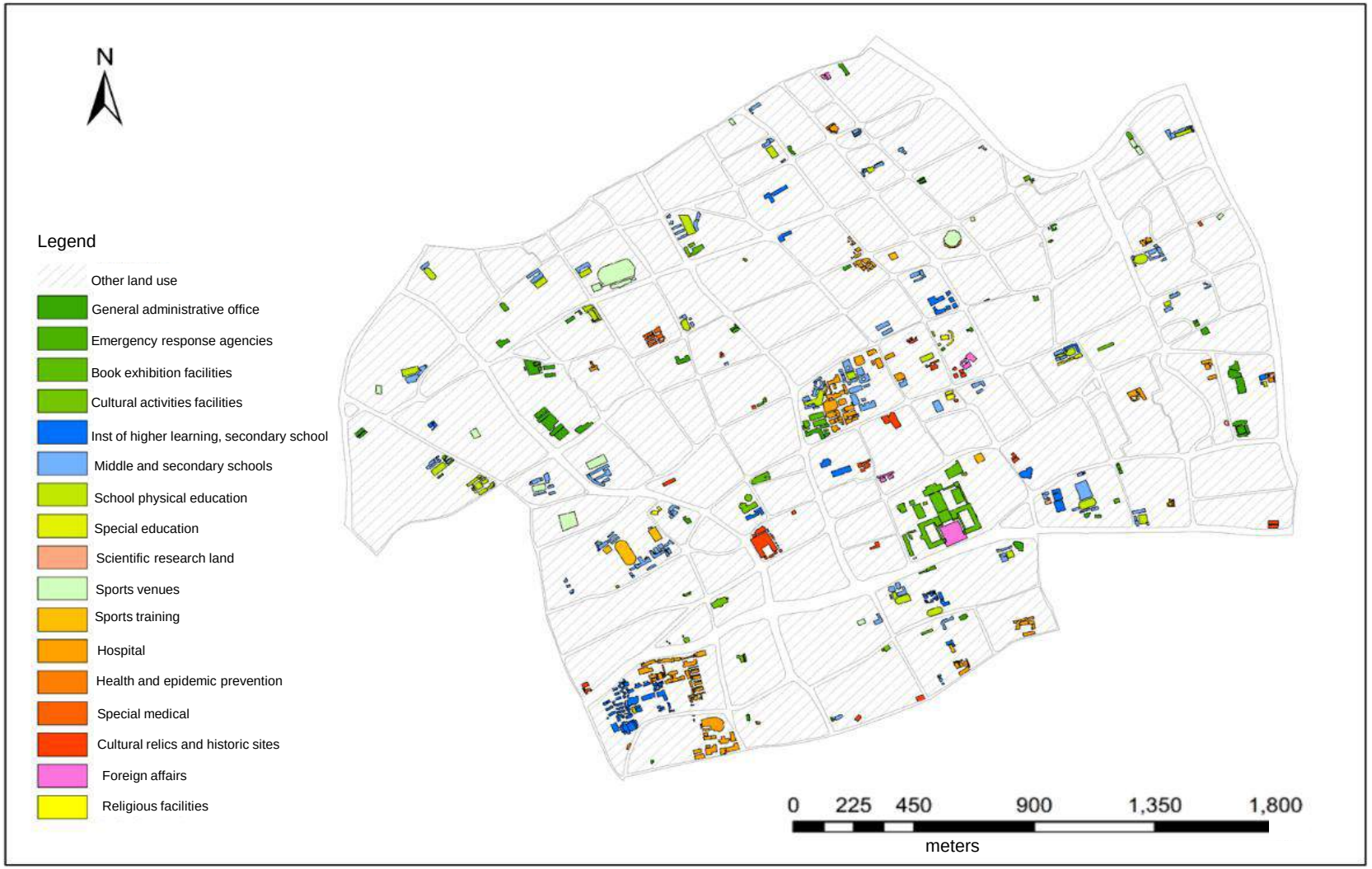


Residential land classification and distribution

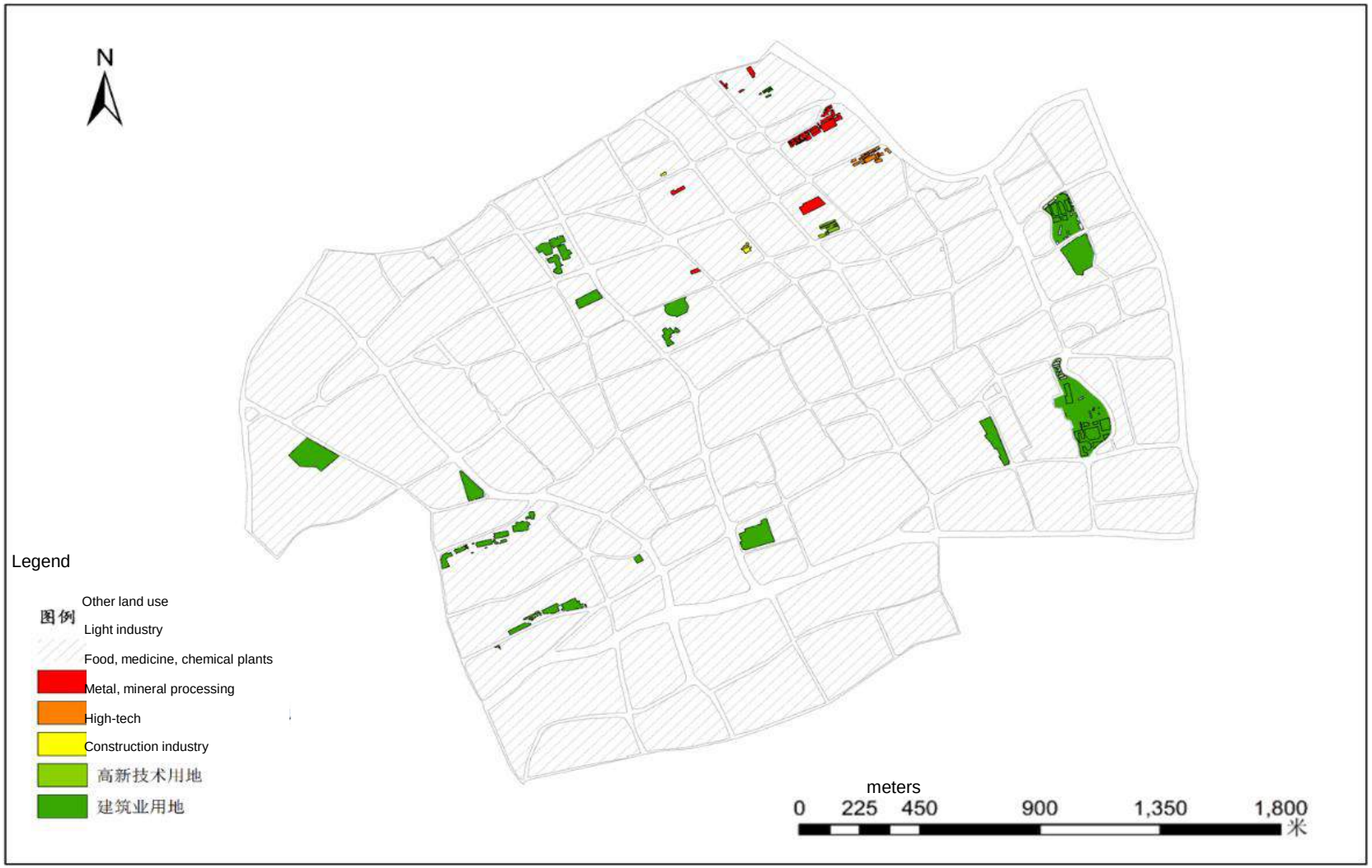


Commercial land classification and distribution

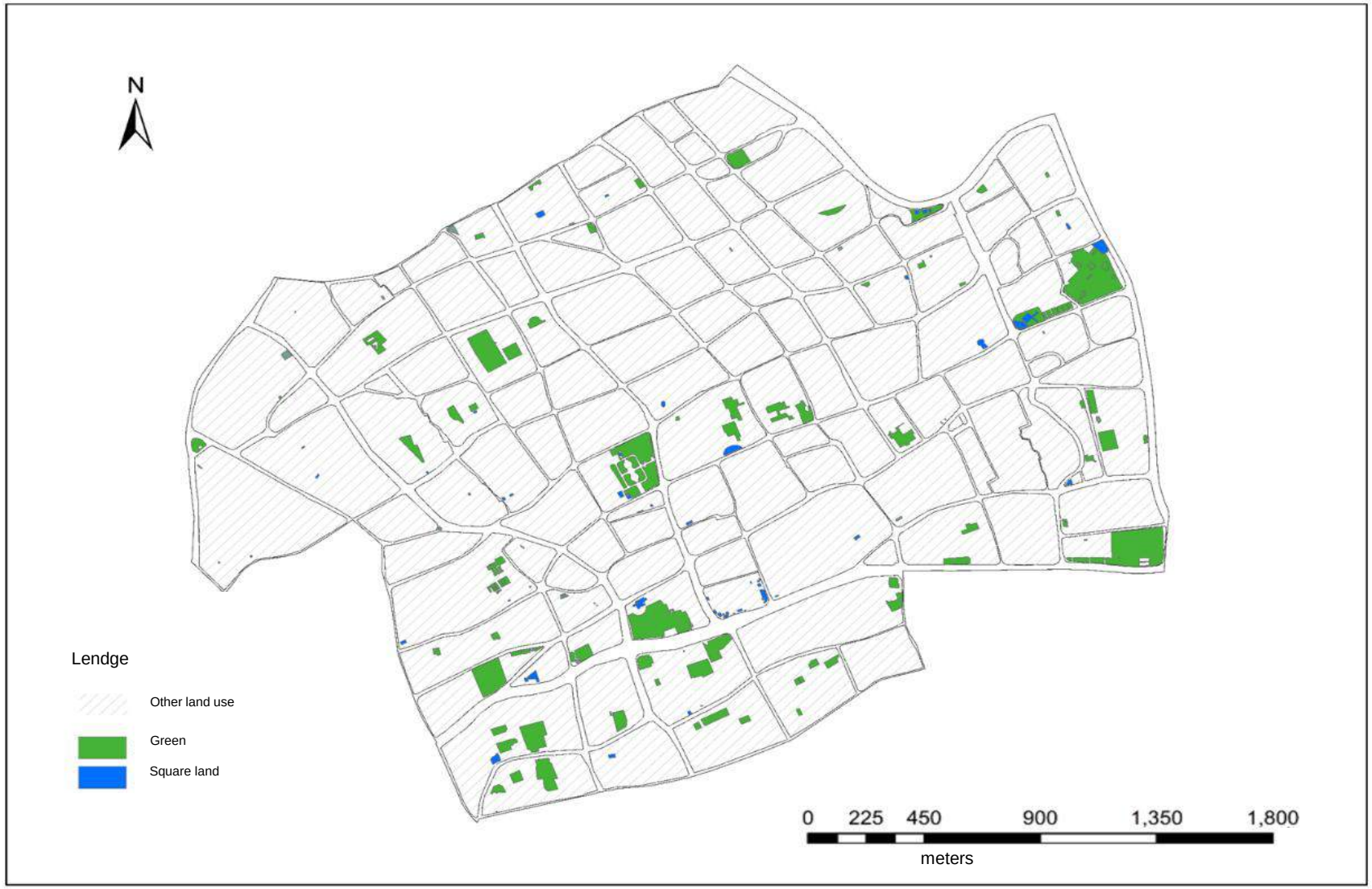
Public management and public service land classification and distribution



Industrial land classification and distribution



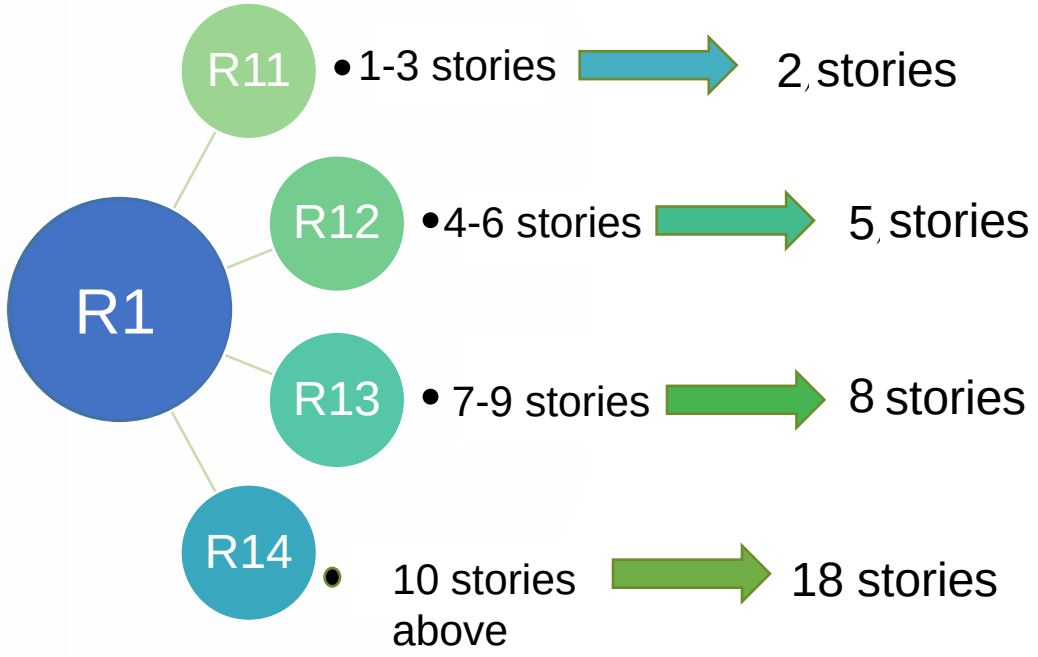
Green space and square land classification and distribution



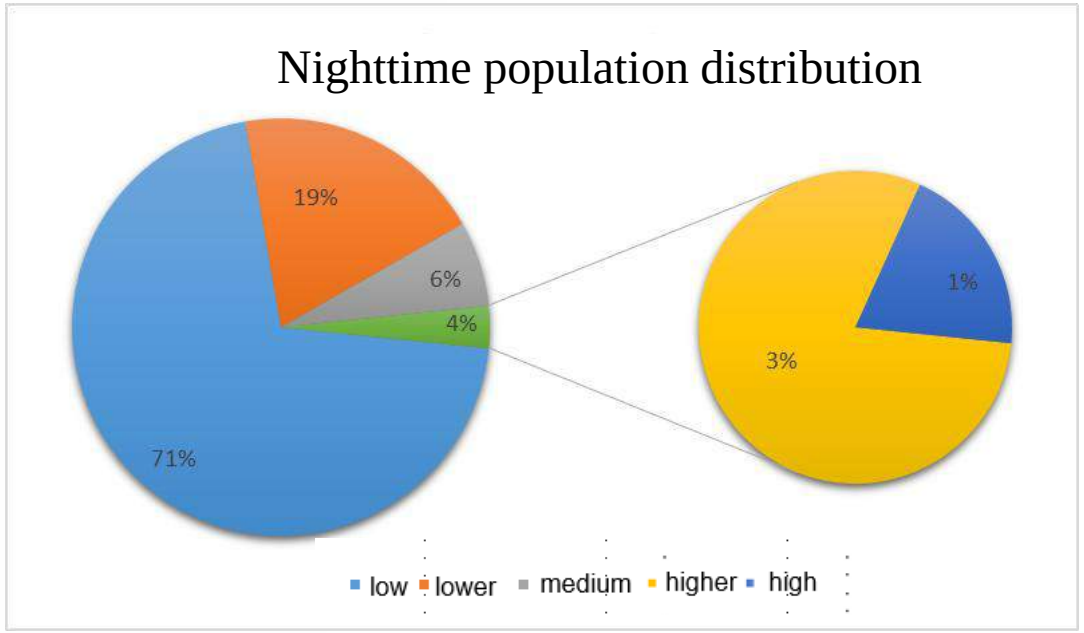
4.1 Nighttime population distribution model

$$BP_i = BA_i * BH_i \left(\frac{CP}{\sum_{k-1}^{n} BA_k * BH_k} \right)$$

where BP_i *is the population of building i, CP, the census tract population,* BA_i *, the* footprint area of building *i,* BH_i *, the average* height of building *i,* i, k , summation indices, and n ,the number of buildings.



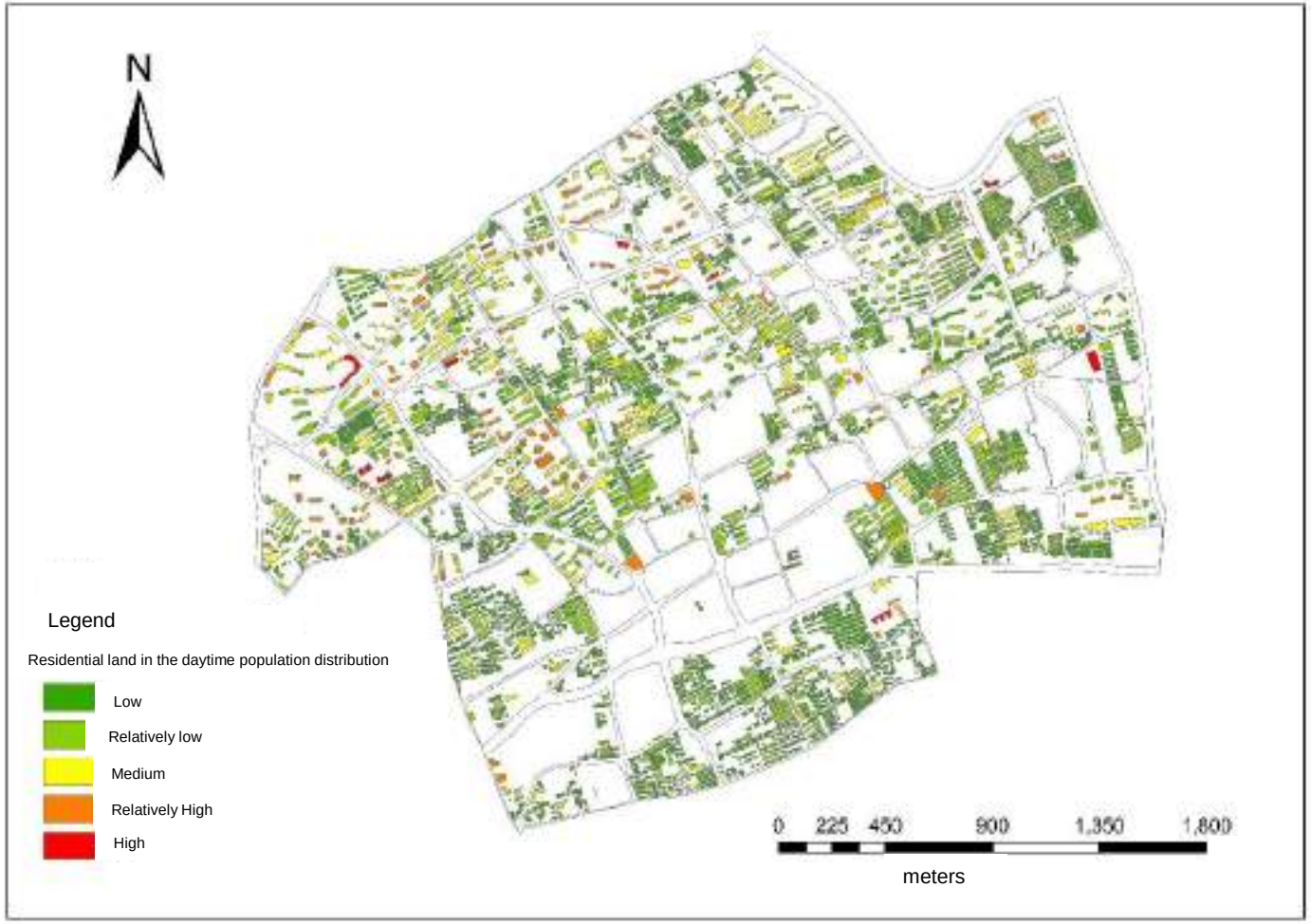
4.2 Results of nighttime population distribution



4.3 Population distribution in residential land during daytime

$$P_\gamma = P_n \times \alpha$$

where P_γ *is the population of residential land during the daytime,* P_n, *the population of residential land at night,* α *= the percentage of infants and aged people.*



4.4 Population distribution in nonresidential land during daytime

$$P_d = \frac{A_m}{\sum A_m} \times P_s \times k_m$$

where P_d = *the population of rest type land during the day,* A_m = *the area of rest type land,* P_s = *the population of working and students,* k_m = *the attracting ratio of every type land.*

In situ survey for k_m *of 20 sub-categories was carried out at 163 sites*

Ten sample sites

B1 commercial facilities
B2 business facilities
B3 entertainment and sports facilities
B5 other services and facilities
B6 hybrid commercial
A1 administrative office
A2 cultural facilities
A3 education and research
A5 medical and health
G1 green
G2 square
M6 construction industry

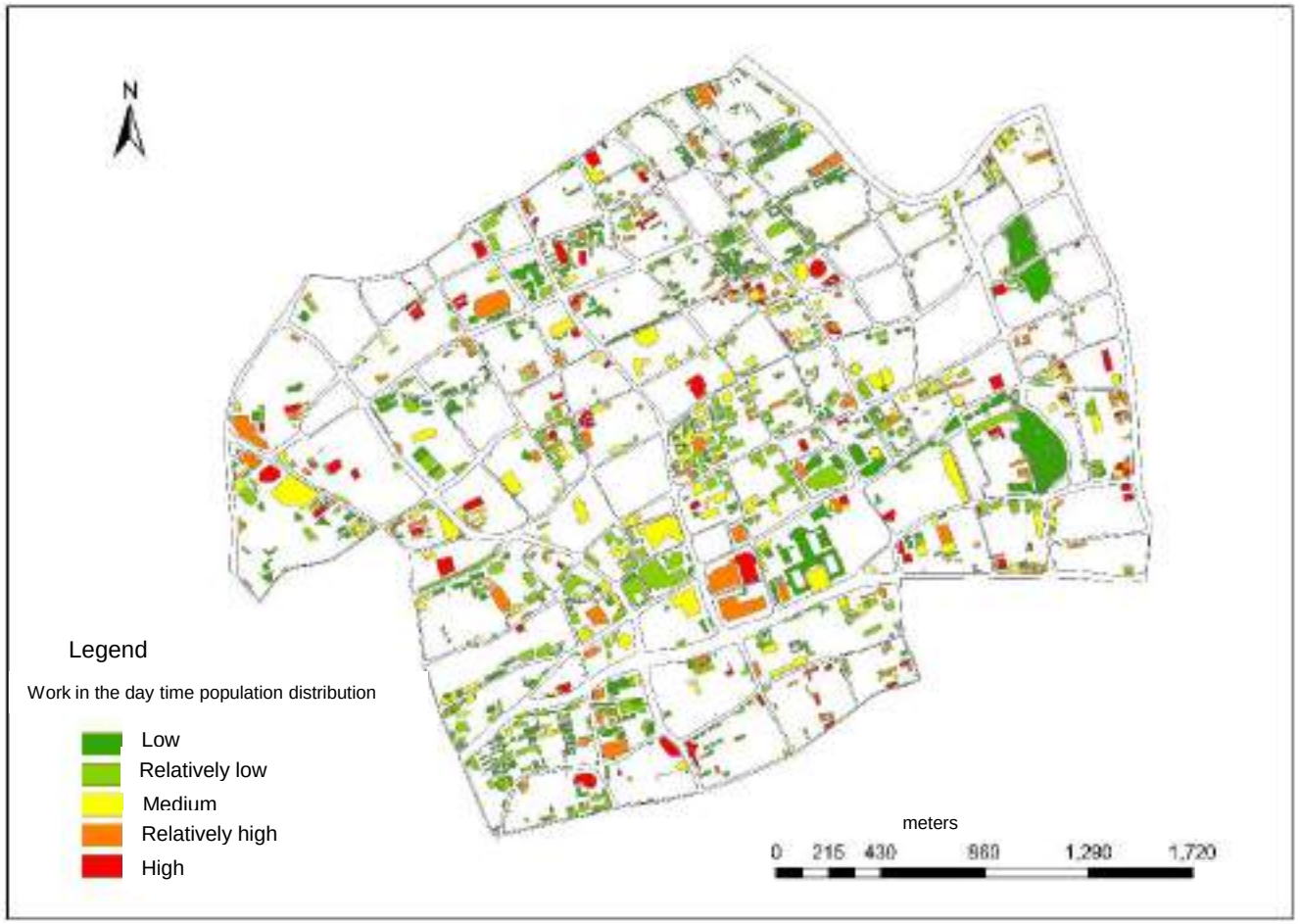
Five sample sites

A7 foreign affairs
M2 light industry
M5 high-tech
M3 food,medicine,chemical plants
B4 utilities outlets

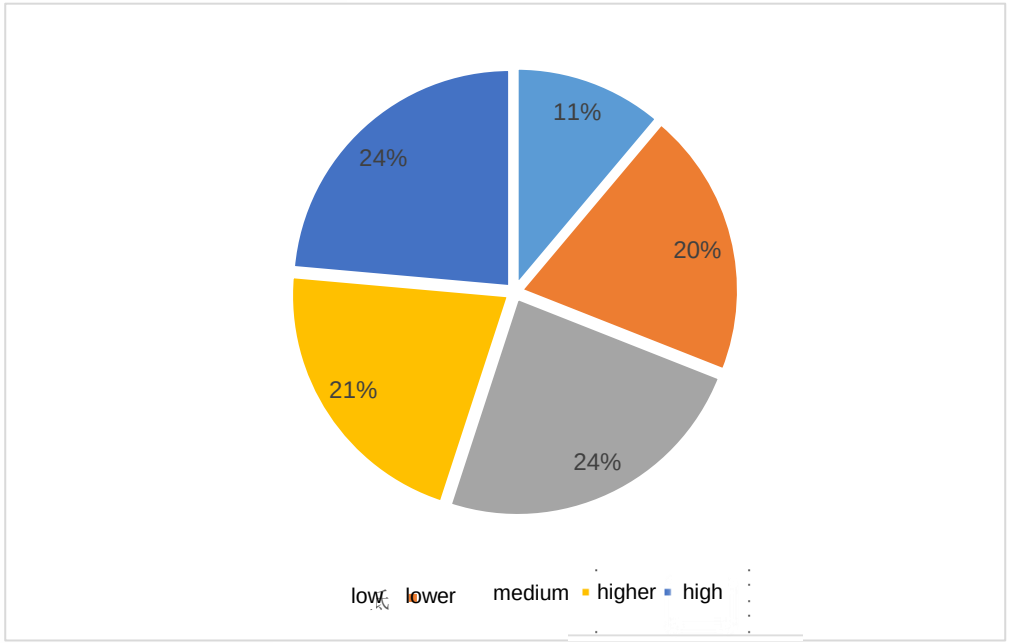
Three sample sites

A8 religious facilities

Daytime population distribution during working hours



The proportion of the population distribution during the day time

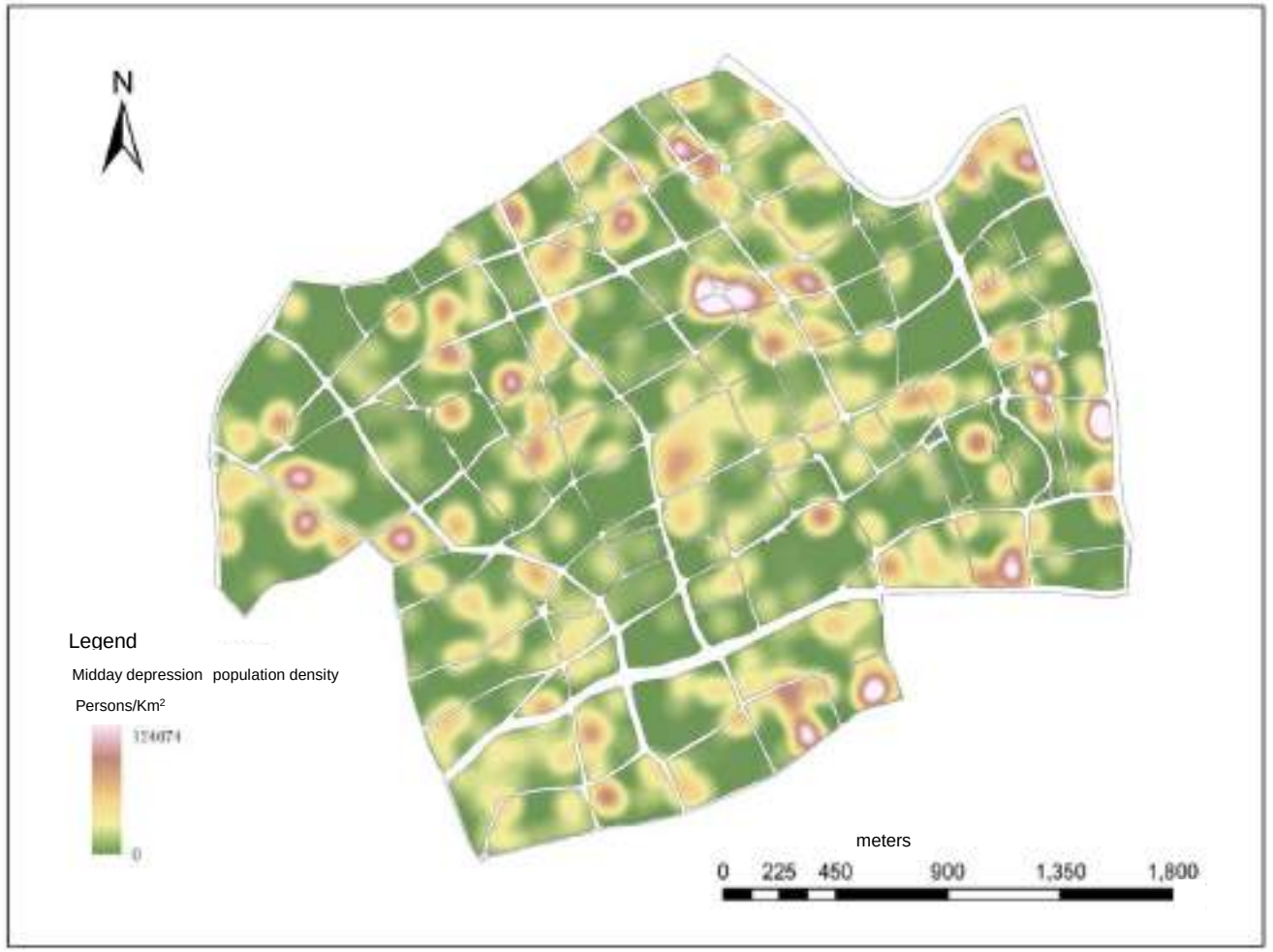


4.5 Population distribution during midday break

$$f_{h(x)} = \frac{1}{Nh}\sum_{i=1}^{N} K\left(\frac{x - x_i}{h}\right)$$

$$\mathrm{K}(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2}$$

where $\mathrm{K}(x)$ *is a Kernel density,* h*, the distance of scope,* n*, the number of dotes in the scope.*

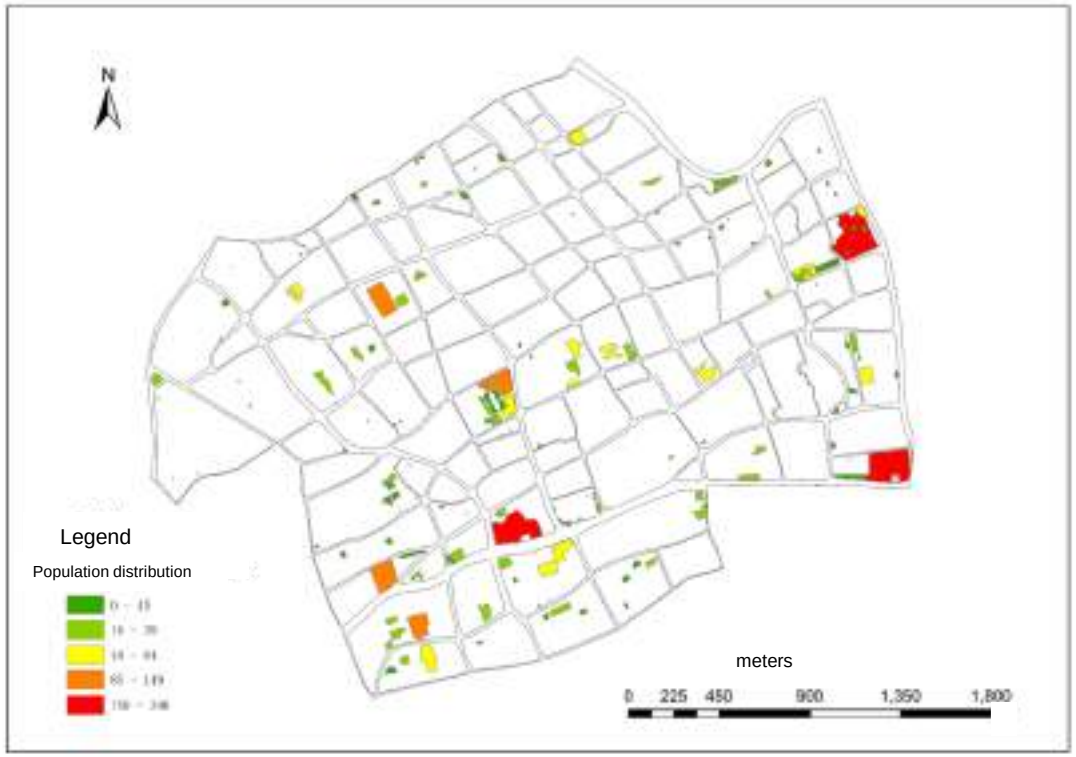


4.6 The green and square land population distribution during the day

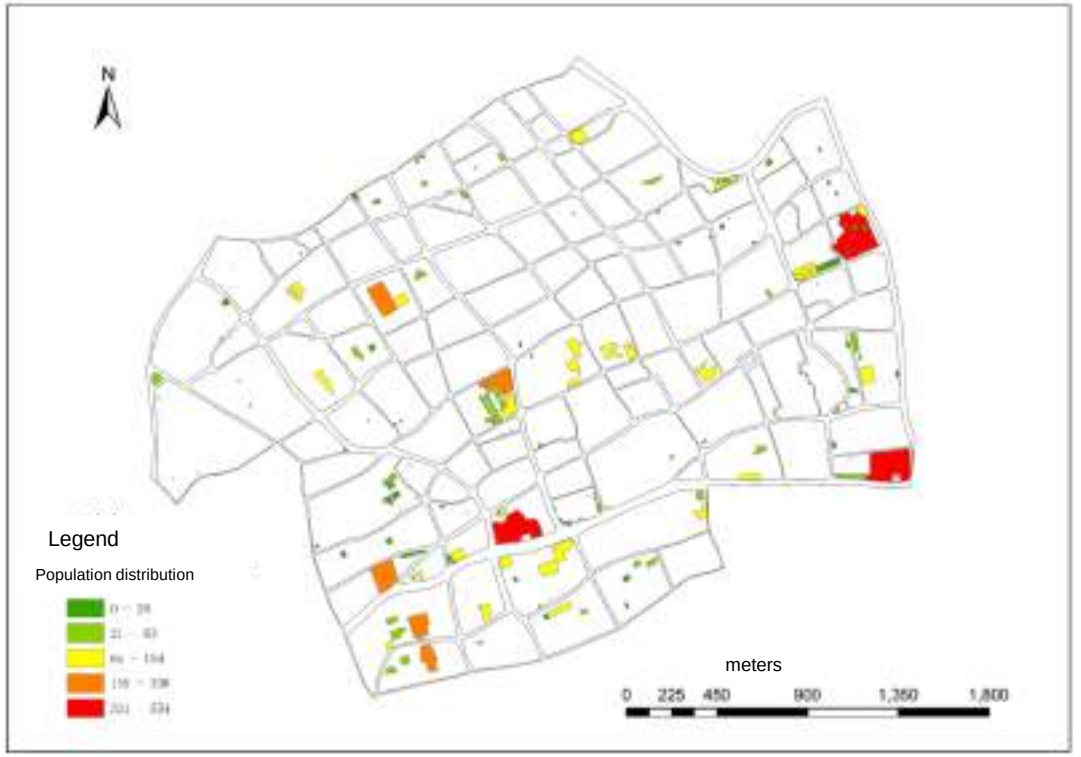
$$P_g = \sum \frac{P_i}{A_i} \times \frac{1}{n} \times A_g$$

where P_g *is the population of green and square land,* P_i *, the population of survery,* A_i *, the area of survey,* n *, the number of survery places,* A_g*, the total area of green and square land.*

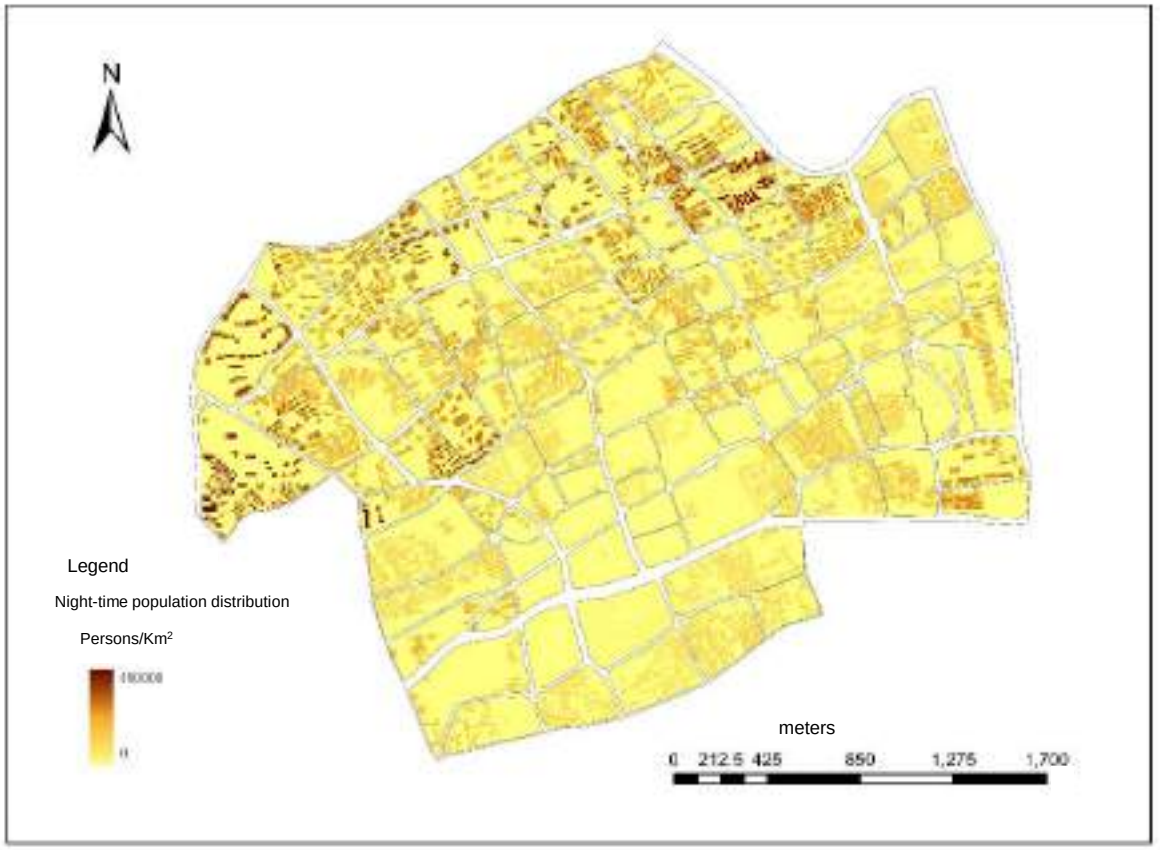
12:00-13:00



18:00-19:00

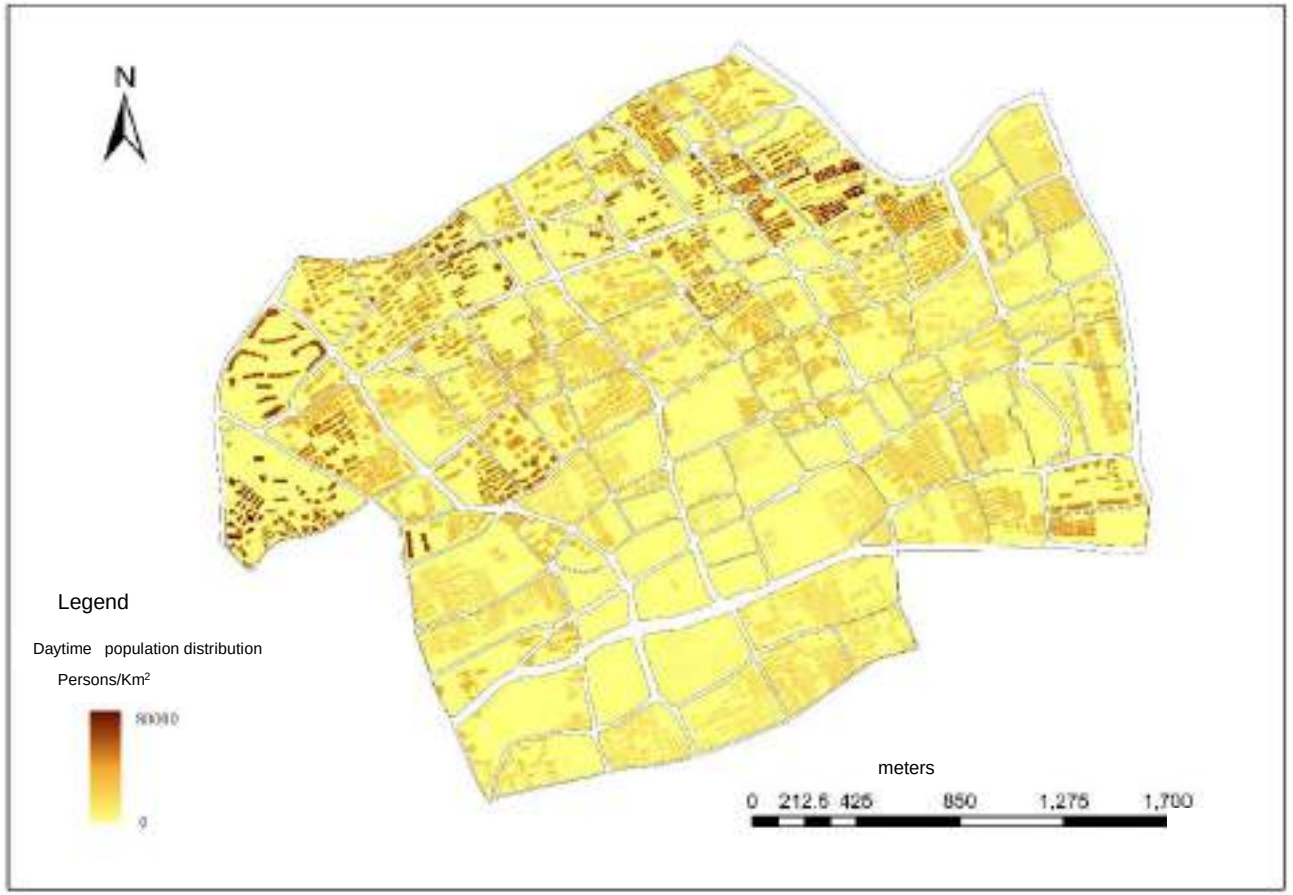


4.7 Gridded population density during nighttime

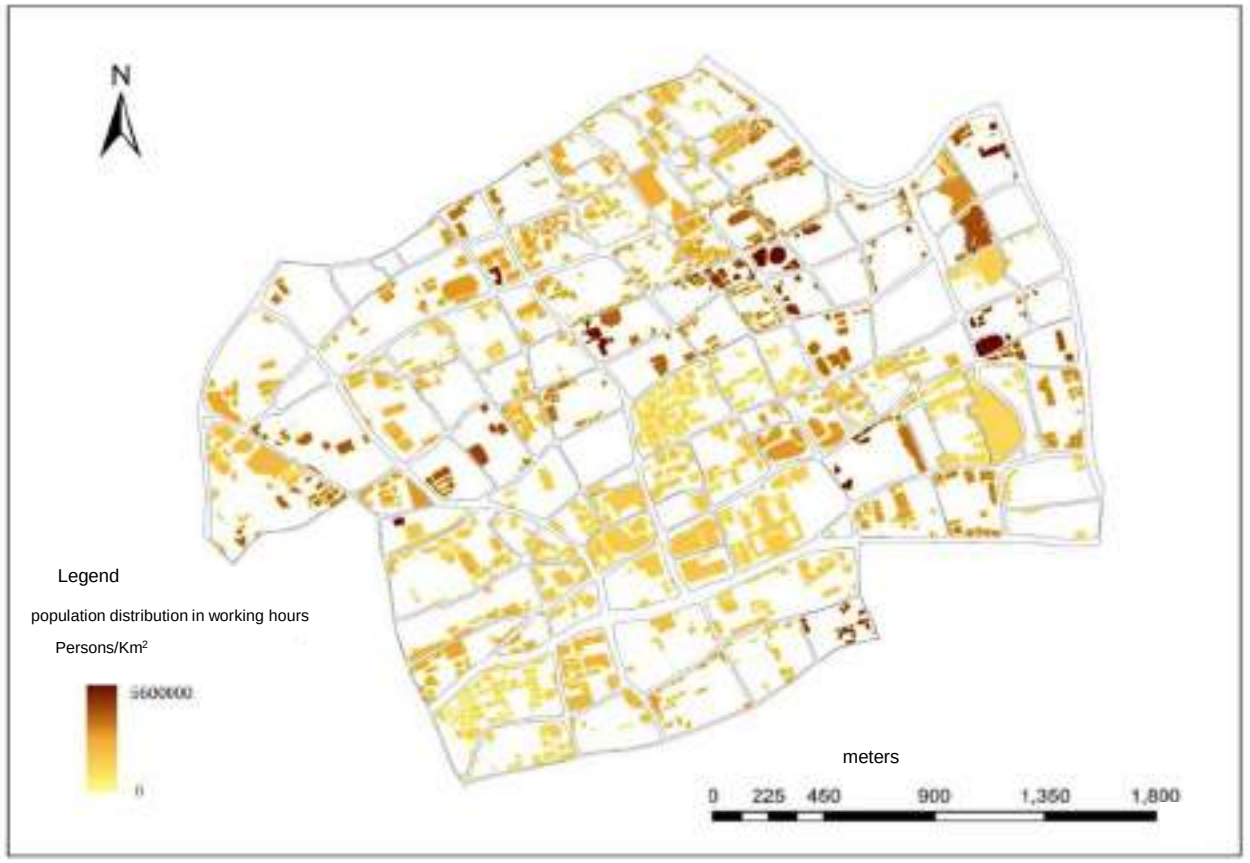


4.8 Gridded population density during daytime

Population distribution in residential land during daytime



Population distribution during working hours



5. Concluding remarks

- We developed a land use classification system for mapping urban population distribution, and interpreted detailed land-use in the study area using high-resolution aerial photographs. We simulated urban population spatial distribution in four time periods in a routine working day.
- However, urban population movement is complex in reality, especially dynamically changes on holidays, with different seasons.
- We didn’t consider population attributes closely related to social vulnerability, such as aged, children, female, disabled, and more efforts should be made in further study.

Thanks!