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Do residents of Affordable Housing Communities in China suffer from relative accessibility deprivation? A case study of Nanjing

ABSTRACT

Affordable housing has emerged as a key issue in urban development in a wide range of countries. Themes in research on affordable housing development across the world are reviewed. Affordable housing communities for low income households have been built on a large scale in developing countries such as China during the last two decades, mainly in urban fringe areas. Evidence on the impact of the location on access of residents to services is rare. Studying Nanjing, this paper compares spatial access to services between Affordable housing communities and Other housing communities by measuring distances and imputing walking time between residential land parcels and facilities. Affordable housing communities have significantly poorer access than Other housing communities, because of poor neighbourhood provision of low order services and poor access to high order services. A household survey of Affordable housing communities and Other housing communities records the daily lives, degrees of satisfaction and community attachments of residents. Residents in affordable housing have low degrees of satisfaction, weak community attachments and desire to move. The findings emphasize that service provision should be planned to keep pace with Affordable housing construction, so that these communities become better places to live.

Keywords: Relative accessibility deprivation; Affordable housing communities; Nanjing; Services; Spatial patterns of access

1 Introduction

Income inequality within countries varies between world regions, being highest in Latin America and Sub-Saharan Africa and lowest in Industrialized Countries and Eastern Europe and Central Asia with some declines and some increases between 1988 and 2013 (Roser & Ortiz-Ospina, 2018). The 1985-2015 period has seen continued urbanization, particularly in less developed countries (UN 2018). In most countries, these trends pose the challenge of providing decent housing for the growing poor population of cities. To house the poor, many countries build affordable housing (also termed social or public housing) for low-income households. Today affordable housing has become a fundamental part of housing provision systems worldwide. In advanced economies, although social housing has been in numerical decline for several decades, it remains a major provider of homes (Pawson, Lawson & Milligan, 2011). For instance, in UK and Austria around a fifth of households live in social housing; in the Netherlands the sector accounts for 30% of all dwellings; Denmark, Sweden, Finland and France have shares of 15% or more (CECODHAS, 2012). Meanwhile, in many developing and emerging economies, large-scale social housing programs have been launched as countries rapidly urbanize. Sixteen developing countries have mounted multi-billion-dollar urban subsidy programs in the past few years (Buckley, Kallergis & Wainer, 2016). Ambitiously, China planned to develop 36 million social housing units between 2011 and 2016 (Zou, 2014).

Affordable housing is generally located in the outer areas of cities. In many European and North American countries, affordable housing for low-income households has been dispersed out to the urban periphery, a process described as the ‘suburbanisation of poverty’ (Kneebone & Garr, 2010; Fenton et al., 2013). For example, in London, there has been a small reduction in inner city social

housing, and the needs of poor households are increasingly met by private provision, where price is closely tied to location (Fenton et al., 2013). In France, recently only 10% of new social housing has been built in the Paris region, where 20% of the French population lives (Wong & Goldblum, 2016). In developing countries, high land costs and difficulties in assembling large land areas with planning permission make it difficult to build affordable housing in accessible central locations (Libertun de Duren, 2018; Chen et al., 2015). For instance, between 1999 and 2009, over 70% of affordable housing in Beijing was built in the urban fringe (Dang et al., 2014). In Brazil and Mexico, new social housing is also predominantly constructed in the urban periphery (Libertun de Duren, 2018).

The practice of locating affordable housing in the urban periphery can lead to poverty concentration, increased segregation by income group and lack of services in poorer neighbourhoods (Schwartz, 2006; Apparicio & Séguin, 2006; Ryan & Enderle, 2012; Woo, A., & Kim, Y. J., 2016). For instance, Apparicio and Séguin (2006) reported that approximately half of public housing residents in Montréal suffer from poor access to services because of the peripheral location of their housing. A state agency in the UK also noted that the "poorest neighbourhoods often receive the poorest services" (SEU, 2000). So, a new agenda was adopted which identified delivery of core services as the 'main weapons' for tackling neighbourhood-level disadvantage and socio-spatial polarization (Hastings, 2007). Similar issues are found in other countries around the world. Local authorities often fail to provide good access to services when locating affordable housing (Woo & Kim, 2016; Talen & Koschinsky, 2011; Ibem, 2013; Yang et al., 2014; Ma et al., 2018; Martínez et al., 2018).

Many studies have examined the poor access to services in affordable housing using spatial analysis but most focus on just one service such as health care or food stores or parks. There is a need to investigate access to a broader range of services and to design composite measures that capture more fully the impact of lack of access on Affordable Housing Communities. Low-income households have difficulties in accessing services and carrying out routine daily activities compared with a reference group (Preston & Raje, 2007; Páez et al., 2010). However, few studies compare access to services in Affordable Housing Communities with access in Other Housing Communities. Many studies survey the experiences of residents of social housing (Norris & Hearne, 2016; Ruel et al., 2013) or of developers of social housing (Libertun de Duren, 2018), but these are not linked to a comprehensive spatial analysis for whole cities.

To improve on studies to date, the current study of Nanjing aims to research a comprehensive range of services and to implement accessibility measures for all residential communities so that Affordable Housing Communities and Other Housing Communities can be compared. So, we will measure spatial access to services of poor communities relative to not-poor communities. The study also includes the experiences and views of Affordable Housing Communities residents gained through a sample household survey. The survey gathered information about household attributes, use of services and satisfaction with access to services to reveal more fully the deprivation experienced by low-income households. The aim of this research is to explore the relationship between the location of affordable housing, access to services and relative accessibility deprivation. By relative accessibility deprivation, we mean deprivation caused by poor spatial access to services relative to reference

communities. The results will contribute to understanding deprivation in urban communities and, we hope lead to better policies for planning affordable housing.

The rest of this paper is organised as follows. Section 2 provides an overview of literature on affordable housing and deprivation from a global perspective. In Section 3, study area, data and methods are described. Section 4 presents measures of spatial access to community services in Nanjing, China and the relative accessibility deprivation of Affordable Housing Communities compared with Other Housing Communities. Section 5 discusses the policy implications of the analysis. Finally, in section 6 we summarise findings and propose a future research agenda.

2 Review of the literature on affordable housing and deprivation

2.1 Global perspectives on the development of affordable housing in cities

Affordable housing differs in meaning across countries but there are common features. In this research, affordable housing is defined as any housing for low-income households with a specified price, mortgage cost or rent that meets an affordability criterion. When low-income households can reasonably afford housing, they are less pressured to move when their budgets are strained and can maintain their daily life, contribute to their neighbourhood community and over longer periods achieve upward mobility. Although affordable housing is considered as an indispensable part of the public agenda around the world, housing policy is a highly local issue. Thus, we need to compare the practices of different countries across the world. Based on reading articles from the mainstream "urban and housing studies" journals over the last five years[1], we summarise findings using a topic–location framework for affordable housing and access to services set out in Table 1.

In developed countries, affordable housing has been built since World War II and so is located throughout the city, in both inner city and peripheral areas (Apparicio & Seguin, 2006; Fenton et al., 2013; Woo & Kim, 2016; Górczyńska, 2017). Since cities are highly developed and populated, in the last two decades revitalization has been the main form of social housing development rather than building new affordable housing (Fenton et al., 2013; Varady & Matos, 2017). Mixed-income redevelopment has become a popular strategy for improving the supply of public housing in the United States (US), Western Europe and Canada (Apparicio & Seguin, 2006; Fenton et al., 2013; Ball, 2016; Norris, M & Hearne 2016; Varady & Matos, 2017). New supply is often developed through public–private partnerships and involves the redesign of modernist projects in line with contemporary planning trends (August, 2016; Norris & Hearne 2016). The classic model for this approach is the US HOPE VI program, which provided federal funding to housing authorities for the demolition and redevelopment of "distressed" projects, and for the dispersal of residents with housing vouchers (Jourdan et al., 2013; Varady & Matos, 2017). However, critics see this mixed-income revitalization as a neoliberal project associated with dismantling the welfare state, a means of promoting privatization, a market-driven policy, and state-facilitated gentrification (August, 2016). A protest organization, We Call These Projects Home, portrays US housing policy as a radical attack upon a system of housing provision that was already marginal (Fenton et al., 2013; Jourdan et al., 2013;

[1] We searched the main "urban and housing studies" journals including Cities, Urban Studies, Urban Geography, Habitat International, Housing Studies, Landscape & Urban Planning and Housing Policy Debate in last five years. This search produced 203 articles related to affordable housing, the most important of which are reviewed here. Relevant articles in other journals are also included.

August, 2016). Also, there are some common trends in policy in developed countries, such as the move from providing the housing directly to low-income residents to personal subsidies for open-market renting (Ball, 2016; Power, 2012; Kitzmann, 2017). This shift means that the socio-spatial organisation of the city is more decisively determined by market pricing, as well as diminishing security for low-income tenants (Górczyńska, 2017). It should be stressed that the details of housing policy and trends differ widely across developed countries (Varady & Matos, 2017).

Some negative results of the revitalization have also been noticed. Studies in the US show that, although affordable housing developments are dispersed and penetrating the suburbs, they are not expanding services or opportunities for the low-income households (Van Zandt & Mhatre, 2009; Wo & Kim, 2016). In other developed countries such as the United Kingdom (UK), in the context of commodification of social housing and gentrification in inner city, social housing is pushed out of inner city and located in more peripheral areas (Fenton et al., 2013). Recent changes in government housing policy and urban development make social housing more dispersed in the urban space. Affordable housing communities, especially when located in suburban areas, have poor access to services (Apparicio & Seguin, 2006; Apparicio et al., 2008; Van Zandt & Mhatre, 2009; Woo & Kim, 2016).

In developing countries, affordable housing was built later compared to developed economies, and in massive projects are still being constructed. In contrast to developed countries, new-built housing is the main form of affordable housing development due to the fast-growing urban population and high degree of inequality (Buckley et al., 2016; Libertun de Duren, 2018; Chen et al., 2015). The government is the dominant player, while the commercial developer also plays an important role (Zou, 2014; Libertun de Duren, 2018). However, due to the high land price in the inner city, abundant unexploited land in suburbs, and the interest of developers and government, newly-built affordable housing is usually located in urban fringe area (Libertun de Duren, 2018; Martínez et al., 2018; Dang et al., 2014). As a result, access to services for residents in affordable housing in the urban periphery is often poor (Martínez et al., 2018; Ma et al., 2018; Yang et al., 2014).

In summary, although governments from different countries implement distinct strategies for affordable housing, there seems to appear a common trend that affordable housing for low-income households is built in marginalized areas within the city, and many places suffer from poor access to services. While previous research only examined the spatial location of affordable housing and access to services, our study addresses this shortcoming by exploring the relative deprivation experienced by low-income households in a Chinese context compared with better-off households.

Table 1

Different affordable housing practices in the last two decades

Country or World Region	Affordable housing practices in urban development	Location of affordable housing	Access to services	Methodology
USA	Disinvestment, demolition, and privatization; Displacement of low-income people from public housing into mixed-income developments, under HOPE VI program, to reduce poverty concentration and improve social mixing. Preference and funding have instead gone to providing vouchers to subsidies rents paid by poor tenants to private landlords (Jourdan et al., 2013; Varady & Matos, 2017).	Around the city. Demolition without replacement of public housing units has dispersed the one-time residents of public housing (Zandt & Mhatre, 2009; Ryan & Enderle, 2012; Woo & Kim, 2016)	Good access to services as well as poor access; Affordable housing in suburbs have poor access to services (Zandt & Mhatre, 2009; Woo & Kim, 2016)	Spatial analysis (Zandt & Mhatre, 2009; Van Talen & Koschinsky, 2011); Household survey (Jourdan et al., 2013); Policy analysis (Varady & Matos, 2017)
UK	Commodification of social housing; Demolition of public housing and building mix-tenure developments; Move from the direct supply of dwellings to poor households to personal rent subsidies; Sales to sitting tenants under the 'Right-to-buy' (RTB) (Fenton et al., 2013).	Around the city ,but social housing is pushed out of the inner city. More social housing is located in the urban fringe area. Subsidized housing has become more suburban and more spread out (Fenton et al., 2013).	Good access to services as well as poor access (SEU, 2000; Macintyre et al., 2008; Fenton et al., 2013).	Statistical analysis (Fenton et al., 2013); Spatial analysis (Macintyre et al., 2008); Qualitative analysis (Fenton et al., 2013).
Canada	Revitalization is underway to create a mixed-use, mixed-income communities — with rebuilt public housing, condominiums and a redesigned landscape. Dispersing public housing throughout its territory with the construction of small buildings in all districts within the city (August, 2016).	Dispersed throughout the city (Apparicio, Seguin, 2006; Apparicio,et al., 2008).	Residents of public housing in the suburbs have limited accessibility to services (Apparicio, Seguin, 2006; Apparicio,et al., 2008;).	Spatial analysis (Apparicio & Seguin, 2006; Apparicio,et al., 2008).
Western Europe	End of the social housing boom; substitution of a policy of supporting households through housing benefits rather than new build; but a lot of variety in the degree to which national housing policy provides decent housing for the poor (Ball, 2016; Wong & Goldblum, 2016; Norris, M & Hearne 2016).	Dispersed throughout the city (Kitzmann, 2017; Górczyńska, 2017)	Good access to services as well as poor access (Kitzmann, 2017; Górczyńska, 2017)	Policy reviews (Ball, 2016; Wong & Goldblum, 2016) Spatial analysis (Kitzmann, 2017; Górczyńska, 2017).
China	A multi-level affordable housing system was established (see Table 2); New-building stressed; sales to low-income households at low price or rent to them (Zou, 2014; Chen et al., 2015)	Mainly located in urban fringe areas (Dang et al., 2014; Chen et al., 2015; Lin, 2018).	Poor access to services (Yang et al., 2014; Wei & Chiu, 2018; Ma et al.,2018; Lin, 2018).	Spatial analysis (Yang et al., 2014; Ma et al.,2018; Wei & Chiu, 2018); Policy analysis (Lin, 2018).
Latin America	Affordable housing was built by the private sector with state subsidies; housing units are located according to developers' preferences; serves only urban households rather than informal workers, migrants or shantytown dwellers (Libertun de Duren, 2018).	Mainly located in urban periphery areas (Libertun de Duren, 2018; Martínez et al., 2018).	Poor access to services (Martínez et al., 2018).	Interview surveys (Libertun de Duren, 2018); Spatial analysis (Martínez et al., 2018).
India	A large amount of new affordable housing was built and supplied by the government as well as commercial developers (Gopalan& Venkataraman, 2015).	Far from city centre (Gopalan& Venkataraman, 2015).	Poor access to services (Nathan, 1995).	Policy reviews (Gopalan& Venkataraman, 2015); Household survey (Nathan, 1995).
Sub-Saharan Africa	Western housing policies are judged to be unsuitable for Africa (Tipple 2015). Banks provide finance for housing but not for the poor. Inclusion of a few new satellite cities providing more housing (Buckley et al., 2016; The Economist 2018).	A few examples of urban periphery developments (The Economist 2018).	Poor access to services and infrastructure (Ibem, 2013).	Household survey (Ibem, 2013); Qualitative analysis (Tipple, 2015).

2.2 Affordable housing and urban development in China

China, as the largest developing country in the world, is rapidly urbanizing. Chinese cities have experienced restructuring of their economies and built environments over the last thirty years. Socio-spatial differentiation and the income gap between rich and poor have increased. To solve the housing problems of low-income households, affordable housing has been built on a large scale in Chinese cities in the past two decades. A national policy has been adopted that requires city governments to secure residents' welfare (State Council, 2011a). Initially, the government developed affordable housing projects as a mechanism to support housing reform (Huang, 2012; Zou, 2014). Recently, affordable housing projects have played an increasingly significant role in the social welfare and social security systems. Nowadays, a multi-level affordable housing system has been established in China (Table 2).

Table 2

Main Types of Affordable Housing in current Chinese Cities

Type	Target group	Housing tenure	Providers
Economic and Comfortable Housing (ECH) (Main type)	Low- and middle-income urban households	Mostly owned, small share rental	Developers
Public Rental Housing (PRH) (Main type)	Households which do not qualify for CRH or ECH, mainly for new graduates and migrants	Rental	Municipal government, work units, developers
Capped-Price Housing (CPH)	Low and middle-income households	Owned	Developers
Resettlement Housing (RH)	Households displaced by urban demolition	Mostly owned, small share rental	Municipal government, developers

Source: State Council, 2011a; State Council, 2011b; State Council, 2016; MOHURD, 2012; MOHURD, 2013; Shi et al., 2016; Zhou and Ronald, 2017; Chen J, et al., 2017.

Notes: Since 2014, Cheap Rental Housing has been merged into Public Rental Housing to achieve unified management.

Affordable housing projects provide low-income households with a dwelling only and fail to consider people's other basic needs. This outcome of urban development is a result of political, fiscal and land arrangements. First, the central government has the political authority to appoint lower-level officials in local government and to mandate actions (Xu, 2011). Local government officials gain promotion mainly through their economic performance (Ma, 2007). Although central government requires local governments to construct affordable housing, policy documents do not specify detailed requirements such as location. Second, tax revenue has been shared among local and central governments since the tax system reform in 1994. Local governments must manage their own spending and take responsibility for local welfare (Tian, 2015). Consequently, local governments are reluctant to initiate affordable housing programmes but need to be pushed into action by central government (Chen et al., 2015; Zhou & Ronald, 2017). Last, the urban land market is not yet fully transparent. All urban land is owned, operated and leased by central and local governments. The income from commercial housing and land leasing is a critical source of local government revenue (Tao et al., 2010; Wei and Chiu, 2018). Since land prices in inner-city areas are much higher than in the urban fringe, local governments locate affordable housing programmes in outer urban areas. Land

in the inner-city is mostly occupied by businesses and private housing, producing large revenue streams for local governments (Chen et al., 2015).

Large scale inner-city redevelopment and new town construction programmes have been launched since 2000 in many Chinese cities (Shih, 2010; Wu, 2015). Residential space has been dramatically restructured. Old, low-grade neighbourhoods in inner city areas were replaced by upper-grade private housing and commercial buildings (Huang, 2012; He, 2007). The original low-income residents were moved into housing communities for displaced households in many cities such as Nanjing (State Council, 2011; Nanjing Government, 2015; Zhang et al., 2018). Households with middle and high incomes migrated into the inner city (He, 2007). Farmland was expropriated by local governments to build new towns, industrial parks and university towns (Wu, 2015). The original farmers were required to become new urban citizens in resettlement housing communities. Areas with good infrastructure and services in new towns became middle and upper-class districts. Many affordable housing projects were built in the urban fringe without enough services, such as hospitals, schools or shopping centres. A growing number of research papers on Chinese cities have found that residents living in Affordable Housing Communities experience poor access to services (Yang et al., 2014; Wei & Chiu, 2018; Ma et al., 2018; Lin, 2018; Ye et al., 2017). However, a systematic spatial analysis of accessibility deprivation, enriched by survey responses from residents, has not been carried out.

2.3 Deprivation, access to services and affordable housing

Deprivation is a socio-economic concept, used to explain the situation of disadvantaged groups within urban areas and sometimes rural areas. Townsend (1987) defined deprivation as a state of observable relative disadvantage for an individual, family, group or area, compared to the local neighbourhood community, wider society or other countries. Deprivation is usually measured for populations of areas or groups in society. Measures of deprivation uses scales that relate local situations to a national distribution (Townsend, 1987; Páez et al., 2010). The people living in deprived areas tend to be relatively poor and more likely to suffer from misery (e.g. illness) (Dorling, 1996). Thus, one should compare the status of low-income group with other groups or overall averages (e.g. medians) when studying the deprivation of low-income groups.

The concept of deprivation and the method of measurement have changed over time. Today, deprivation is usually defined as barriers or limited access to material resources such as food, clothing, housing and services, and to non-material resources such as education, employment and social services (Noble et al. 2006; UNDP, 2013; Maguire et al., 2015; Ouyang et al., 2017). Thus, there are components to deprivation. A person suffering from more than one component will experience multiple deprivation. Deprivation is measured using an index for each component and then combined into a general index, using weights. Examples include the Index of Multiple Deprivation (IMD) in the UK and the New Zealand Deprivation Index (NZDep). Recently, studies have focussed on deprivation of access to public services, vulnerability and lack of opportunities for education or employment (UNDP, 2013; Ouyang et al., 2017; Wan & Su, 2017).

Existing studies indicate that access to services is closely related to quality of life. Inequalities in the ability to access available material and social resources can produce further inequalities, affecting living standards, physical health, mental health and personal behaviour, worsening deprivation. For

instance, poor access to health care services means a low rate of presentation by patients with disease symptoms and therefore higher incidence of disease (Wang et al., 2008). Poor access to food stores providing fresh produce may result in over-consumption of foods that lead to obesity (Pearce et al., 2007; Maguire et al., 2015). Poor access to education may mean difficulty in achieving upward social mobility (Field et al., 2004; Xiang et al., 2018). Thus, access to services is not only related to people's quality of life, but also closely affects survival chances and development opportunities. Low accessibility to services by disadvantaged groups will result in deprivation (Pearce et al., 2007; Hastings, 2007; Páez et al., 2010).

Scholars around the world have observed that placing affordable housing in inaccessible locations may lead to further social problems, such as poverty concentration, degradation of the living environment, high crime rates and poor access to services (DeKeseredy et al., 2003; Apparicio & Se´guin, 2006; Crook et al., 2016). Compared to economically advantaged households, low-income households have limited access to service facilities because of the locations assigned to affordable housing (Apparicio et al., 2008; Woo & Kim, 2016). Current practice in planning and building affordable houses focusses on the provision of adequate dwelling spaces and neglects the provision of services for new residents (Woo & Kim, 2016; Talen & Koschinsky, 2011). As a result, Affordable Housing Communities form new areas of poverty in cities, which have poor access to services. Focusing on this problem, scholars argue that public policy should ensure not only the provision of affordable housing, but also provide accessibility to services, businesses and facilities (Apparicio & Se´guin, 2006; Talen & Koschinsky, 2011).

Previous studies demonstrated that affordable housing in urban peripheral areas suffered from low spatial access to services, and the "geography of opportunities" was poor (Apparicio & Se´guin, 2006; Yang et al., 2014; Woo & Kim, 2016; Ma et al., 2018). However, the feelings and degrees of satisfaction of residents are often ignored. The analysis of the consequences of poor access is inadequate. Thus, we pose the following questions: What is the relationship between the poor location of affordable housing and deprivation experienced by low-income residents? Compared with other countries, what is the specific situation of deprivation in Chinese Affordable Housing Communities? What lessons can be learnt by other countries from the Chinese story? To fill these research gaps, our research expands on previous literature by examining the relationships between the location of affordable housing, access to services and deprivation by comparing Affordable Housing Communities with Other Housing Communities, exploring the relative accessibility deprivation of low-income households in a Chinese context.

3 Study area, data sources and methods

3.1 Study area

Nanjing is a major metropolis in Eastern China, located on the Yangtze River. It is one of the Four Great Ancient Capitals of China (Beijing, Nanjing, Luoyang and Xi'an). Like most Chinese cities, Nanjing has experienced rapid economic growth and urbanization since China's economic reforms started in 1979 under Chinese leader Deng Xaoping. Nanjing combines the features of modern Chinese cities and traditional Chinese cities. Nanjing, unlike Shanghai, has not attracted a strong inflow of foreign investment but has avoided the economic decline of old industrial cities in China's north-eastern "rust belt". Nanjing's development follows the favourable process characteristic of most

eastern Chinese cities. Nanjing's problems are reasonably representative of larger Chinese cities and the city provides a useful case study of recent Chinese urban development.

The study area comprises the urban area defined by the report Nanjing Urban Planning 2007-2030 (Fig. 1), which includes the inner city, the outer city, the new towns and other areas. The inner city consists of the urban centre which lies within the Ming Dynasty City Wall. The main urban area falls within the area bounded by Nanjing's belt highway and the Yangtze River. New towns are urban developments based on older urban centres. Other areas are zones adjacent to Nanjing city and the new towns, with a large share of land devoted to industry and agriculture.

Nanjing municipal government has built a high number of affordable housing units since 2000. Many Affordable Housing Communities were built in peripheral areas (Fig. 1), which became new concentrations for disadvantaged groups. In total, 71 Affordable Housing Communities were built from 2002 to 2010, with a built-up area of 17 million m^2 (Nanjing Government, 2017).

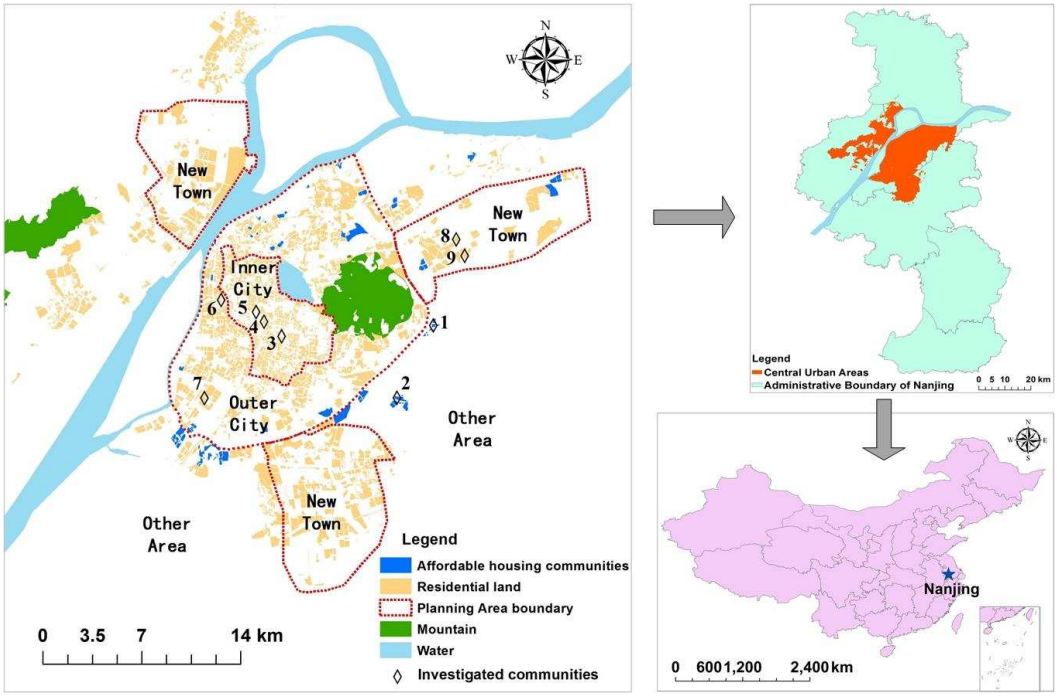

Fig. 1. The locations of the main Affordable Housing Communities in Nanjing

3.2 Methods

In this study, we carry out a geographical analysis to determine the level of accessibility to a variety of services experienced by the residents of Nanjing and compare accessibility levels in Affordable Housing Communities with those in Other Housing Communities. The accessibility index adopted in this study does not attempt to incorporate every facet that may influence people's life, but rather, based upon a survey of the literature, identifies key community service facilities. Facilities for shopping, health care, education, recreations and transportation are community resources most often studied (Witten et al., 2003; Pearce et al., 2006; Lotfi & Koohsari, 2009), and are used in this research.

Six approaches to measuring accessibility to services are commonly used (Talen & Anselin, 1998; Higgs, 2004; Lotfi & Koohsari, 2009):

- The Container method counts the number of facilities within an area.
- The Coverage method counts the number of facilities within a catchment.
- The Minimum Distance method evaluates the distance from an area to the nearest facility.
- The Minimum Travel Cost method estimates the minimum time or cost of journeys from areas to facilities.
- The Gravity method, based on Newton's gravity model, associates accessibility positively with the scale of facilities and negatively with distance to facilities.
- The Two-step Floating Catchment Area (2SFCA) method estimates the accessibility of facilities to an area using a gravity model and sums scores over all facilities.

The Container method is crude, being dependent on a fixed area scale and fixed arbitrary boundaries. The Coverage method refines the area measure by defining a catchment, locations accessible to households or communities, which varies from housing community to housing community. The Minimum Travel Cost method depends on access to travel survey data, and it requires careful evaluation of travel time including congestion and travel mode. The Gravity method and Two-step Floating Catchment Area method are weighted by service size, which is difficult to obtain for the whole city. The Minimum Distance method, which we use, provides a more detailed assessment of accessibility, using available information. It is a widely used method (Witten et al., 2003; Pearce et al., 2006; Apparicio & Séguin, 2006; Su et al., 2017). In this study, the minimum distance between communities and facilities is converted into walking time, which can reflect the difficulty of reaching the various services. Therefore, we adopt the minimum distance method.

Census units are usually employed for the basic residential area. However, in some countries such as China, the smallest census unit, the sub-district, is much bigger than a residential neighbourhood. A census sub-district in a Chinese city contains tens of thousands of people and is too large to be analytically useful. This study adopts a new strategy: parcels of residential land type are extracted from the Map of Land Use and used as the basic analytical units. These residential parcels are identified as using land for housing. Residential parcels vary in size from several hundred square meters to a few square kilometres but house similar numbers of households.

To research spatial accessibility, an operational measure of distance between residential and service locations is needed. One option is the shortest path through the road network to the service location. However, there are problems in implementing this measure. First, digital information on road networks in affordable housing neighbourhoods is either not available or out of date. Second, the shortest path over the road network may not be the one used by residents who travel by bus, metro or bicycle. However, it has been shown that straight-line (or Euclidian) distance is highly correlated with travel time (Phibbs & Lufy, 1995). Travel time is highly correlated with travel cost, which affects the budget of a resident of the affordable housing project. So, this study uses Euclidian distance to measure access to facilities. It has been shown that the shortest path distance is between 1.2 and 1.4 times as long as the straight-line distance (Wang et al. 2013). So, we estimate the shortest path

distance by applying an average ratio of 1.3 to Euclidian distances from land parcels to service locations.

We convert distance to walking time to measure accessibility. The ability to walk to services needed daily is an important indicator for evaluating community quality (Su et al., 2017; Godschalk & Rouse, 2015), especially for Affordable Housing Communities where residents have lower access to cars and public transport. Most residents favour a walking time of no more than 5 minutes and set an upper limit of 10 minutes (Kaplan & Kaplan 1989; Talen & Koschinsky 2011; Lu et al., 2012; Su et al., 2017). As travel time increases, residents are more reluctant to walk. Thus, walking time and the residents' tolerance fit a decay function (Su et al., 2017; Lu et al., 2012). The walking speed of normal-weight adults ranges between 55 and 110 m/min. The preferred walking speed is around 80 m/min (Rose et al., 2005) and we adopt this norm. The correlation between distance and walking time means we can convert distance into time and accessibility levels (Table 3). Accessibility scores are assigned to each residential block according to the link between Euclidian distance and accessibility in Table 3.

Table 3

Correspondences between distance path length, walking time, and the accessibility to services

Accessibility Measure	**Level of Accessibility**				
	Very Good	**Good**	**Normal**	**Bad**	**Very Bad**
The Euclidian distance to facilities (m)	≤300	300-600	600-1200	1200-1800	＞1800
The shortest path distance to facilities (m)	≤400	400-800	800-1600	1600-2400	＞2400
Walking time (min)	≤5	5-10	10-20	20-30	＞30
Accessibility score to single category facility（a_{ij}）	100	80	60	40	20
Accessibility composite score to facilities（A_i）	≥80	61-80	41-60	21-40	≤20

Source: Authors' calculations.

Notes: $A_i=\sum_j w_j \times a_{ij}$, where A_i is the score of residential block i's comprehensive accessibility; a_{ij} is the score of residential block i's accessibility to facility j and w_j is weight of facility j.

The overall accessibility scores to all facilities for residential blocks can be computed from scores to individual facilities. The facilities within the same dimension can be also divided into lower-level and higher-level sub-type. The lower-level facilities satisfy people's basic and daily needs, such as convenience store, first-level hospital and bus stop. The higher-level facilities provide the higher-level services such as large supermarkets and third-level hospital. Although the higher-level facilities may be not a necessity for some people, they will be important for people's lives. For example, the quantity and quality of commodities in large super-markets are better than in convenience stores and prices are lower. Access to large supermarkets will reduce the living cost and increase consumption of healthy foods. In countries such as China, people visit higher-level hospitals directly instead of first going to a general practitioner nearby, because they believe the higher-level hospitals provide the best medical services. Thus, higher-level facilities are also crucial for people's well-being. According to Amartya Sen's capability theory, individuals or households should have the ability and freedom to choose or achieve something that they value (Sen, 1999; Walker, 2005). Everyone should have the equal freedom to choose what he/she wants to achieve. Therefore, we should provide the equal potential opportunities for low-income groups, even if they do not use the higher-level services frequently. Although we could assign different weights to service dimensions, previous studies have indicated there is no consensus on weighting. Existing studies commonly use equal weights for summing scores (Lotfi & Koohsari, 2009). Thus, in this study, each service

dimension is given an equal weight and each facility in a dimension has the same weight. To establish that the general results of study are not significantly affected by using different weights, we also defined the weights applied to services using an estimates frequency of use, to ascertain the sensitivity of results to alternative weightings of services (Table 4). A comparison of the impact of uniform versus use-frequency weights of the results is provided in Table 7, discussed later in the paper, along with a comparison of results by level of a service in a hierarchy.

Table 4

Service dimensions, facilities and weights

Service, Level, Facility	Main Analysis		Alternative Analysis		
	Weight in Dimension	Weight Overall	Days Service Used out of 365	Weight in Dimension	Weight Overall
Education	1.000	0.200	400	1.000	0.435
Upper: Middle School	0.500	0.100	200	0.500	0.217
Lower: Primary School	0.500	0.100	200	0.500	0.217
Health Care	1.000	0.200	65	1.000	0.071
Upper: Third-level Hospital	0.333	0.067	15	0.231	0.016
Middle: Second-level Hospital	0.333	0.067	20	0.308	0.022
Lower: First-level Hospital	0.333	0.067	30	0.462	0.033
Shopping	1.000	0.200	225	1.000	0.245
Upper: Shopping Mall	0.333	0.067	25	0.111	0.027
Middle: Large Supermarket	0.333	0.067	50	0.222	0.054
Lower: Convenience Store	0.333	0.067	150	0.667	0.163
Recreation	1.000	0.200	80	1.000	0.087
Upper: Waterfront	0.500	0.100	30	0.375	0.033
Lower: Park	0.500	0.100	50	0.625	0.054
Transport	1.000	0.200	150	1.000	0.163
Upper: Metro station	0.500	0.100	50	0.333	0.054
Lower: Bus stop	0.500	0.100	100	0.667	0.109
Totals		1.000	920		1.000
Upper+Middle		0.567			0.424
Lower		0.433			0.576

3.3 Data sources

This study combines spatial analysis of the whole city with a household survey of a sample of Affordable Housing Communities and Other Housing Communities. The spatial analysis examines accessibility to a full range of services not just one. The household survey was administered by the first author to gather information about household attributes, use of services and satisfaction with their accessibility. The integrated use of both spatial and survey methods in this research is innovative in the context of accessibility studies.

To analyse spatial access to facilities we employ the Land Use Map of Nanjing from Nanjing Land & Resources Bureau. This study uses ArcGIS 10.4 to extract 24,467 residential land parcels with their associated centroids, which are used points of origins. The parks and water are also extracted from the land use map of Nanjing. The directory of health care and education facilities of Nanjing comes from Nanjing Public Health Bureau and Nanjing Education Bureau. Geocoding (or address matching) was undertaken to assign map co-ordinates to facilities' addresses. This means the co-ordinates of health care and education facilities were obtained from Google map using their addresses. Then the extracted co-ordinates are employed to locate facilities on the map. Data for other services are downloaded from Amap.com, which is a website in China showing the location of all service facilities. The data contains the name, co-ordinates and address of each facility. The data for

facilities and residential parcels are loaded and analysed in the working map after conversion into the same coordinate system and projection.

To gather information on the attitudes and opinions of Nanjing residents about services, a questionnaire survey was carried out in two Affordable Housing Communities (ACs) and seven Other Housing Communities (OCs) for comparison. Fig.1 shows the location of the communities, distributed across the four urban zones of Inner City (3 communities), Outer City (2), New Towns (2) and Other Areas (2). Table 5 names and describes the communities. Within each community, household addresses were selected from the city registration lists using a simple random method. The survey was conducted in 2014 with the help of a class of undergraduates in human geography attending Nanjing Normal University. Some 900 questionnaires[1] were delivered to households; 772 (86%) valid responses were returned. The questionnaires were completed by an adult member of the household, normally the head or spouse. The questionnaire asked for the following information: (1) age, education, occupation, income and household numbers; (2) residents' daily behaviour such as shopping, visits for health care appointments and commuting to work or school; and (3) satisfaction with and feeling about the community. When disadvantaged residents had difficulty in completing the survey, an interview was conducted. To investigate the feelings of residents and the reasons for deprivation, semi-structured interviews were conducted. Unfortunately, it was not possible to check the representativeness of the survey against the 2010 census, because rapid growth of the population of the four-year gap between census and survey dates.

Table 5

The general character of each community and information about the survey

No	Name	Type	Housing Type	Location	Types of residents	Valid responses
1	Baishuiqiancheng	AC	Affordable housing	Suburban	Low-income residents, resettled urban residents from inner-city and resettled farmers from the local area	110
2	Yinlonghuayuan	AC	Affordable housing	Suburban	Low-income residents, resettled urban residents from inner-city and resettled farmers from local area	74
3	Youfuxincun	OC	Danwei housing	Inner city	Workers of state-owned enterprise; middle class living here for children's education	96
4	Wutaihuayuan	OC	Commercial housing	Inner city	Middle class and high-income households	46
5	Beidongguashi	OC	Danwei housing	Inner city	Staff in universities; middle class	52
6	Longjianghuayuan	OC	Commercial housing	Outer city	Middle class	114
7	Ladefangsi	OC	Commercial housing	Outer city	Middle class and high-income households from private companies	112
8	Xiangzhangyuan	OC	Commercial housing	New town	Middle/high income households from public institutions and companies	118
9	Shanshuifenghua	OC	Commercial housing	New town	High-income households	50

Notes:

1. AC = Affordable Housing Community; OC = Other Housing Community
2. See Fig. 1 for the location of communities.
3. Commercial housing is built with private capital and sold to households with savings sufficient to buy the property.
4. Danwei housing was the main dwelling type in Chinese cities before housing reform in 1995. It was built by enterprises and governments and rented to employees at a low price. From 1995, Danwei housing was sold to occupiers. Danwei housing units can be traded in the housing market and so are part of the commercial housing sector.

[1] A copy of the questionnaire in the original Chinese or translated into English is available from the first author.

Table 6 provides summary statistics for the populations of ACs and OCs. Residents in ACs are younger, have less education, have lower incomes, have a poorer occupational profile and have larger households.

Table 6

Comparison of resident attributes in affordable housing and Other Housing Communities (%)

Variable	Category	AC	OC	Variable	Category	AC	OC
Gender	Male	51.6	50.3	Occupation	Government employees	2.2	4.1
	Female	48.4	49.7		Public institution staff	6.6	16.3
Age	< 30	42.2	22.5		Enterprise managers	6.6	14.3
	31-49	38.9	48.8		Private entrepreneurs,	9.9	6.2
	≥50	18.9	28.7		Company employees	15.4	8.5
Marital status	Married	31.1	17.0		Teachers & researchers	0.0	8.2
	Unmarried	68.9	83.0		Health professionals	0.0	2.4
Education	≤junior schools	24.7	10.7		Commercial service staff	7.7	3.4
	High school	21.3	14.5		No fixed jobs	23.1	6.1
	Junior College	28.1	19.0		Retired	5.5	17.0
	College	22.5	38.3		Unemployed	13.3	0.7
	≥postgraduate	3.4	17.6		Unknown	9.7	12.8
Household	≤5000	34.1	10.5	Household	1	4.5	3.1
Income (yuan per month)	5000-10000	42.0	30.5	members	2	9.0	11.8
	10000-20000	22.7	36.8		3	38.2	48.8
	≥20000	1.1	22.1		4	23.6	18.1
					≥5	24.7	18.2

Notes: AC = Affordable Housing Communities, OC = Other Housing Communities

4 Results

4.1 The poor access to services in Affordable Housing Communities

We calculate the accessibility score of services in all Affordable Housing Communities (ACs) and Other Housing Communities (OCs) in Nanjing. Table 7 shows the descriptive statistics for services provided in both kinds of communities. The access score for all service sub-types in ACs is lower than in OCs, except for convenience stores. The t-test results indicate that the difference in access to all service sub-types is significant at the 99.9% level, except for metro stations. The ratio of the mean accessibility in OCs to the mean in ACs ranges from 1.11 (transport and shopping) to 1.57 (education) for types and from 0.98 (convenience store) to 2.37 (second level hospitals) for sub-types. The difference in scores for access to metro stations is insignificant because there were few metro lines in Nanjing in 2014 and so the access is low in all communities. The poor access to services represents relative accessibility deprivation for Affordable Housing Communities.

Table 7 reports on the results of an alternative analysis, in which the weights of services are determined by frequency of utilization. The alternative access scores for all sub-types in ACs are lower than in OCs, as in the main analysis. The t-test of differences in access across all service sub-types is significant at the 99.9% level, which is the same as in the main analysis. Although the mean scores in the alternative analysis increase because more weight is given to lower-level services, the access scores for all service sub-types in ACs are significantly lower than OCs. This sensitivity analysis enables us to conclude that the general results of study will not be significantly affected by using different weights.

Table 7

Access scores for community services in Affordable Housing Communities and Other Housing Communities

Service, Level, Facility	Main analysis			Alternative analysis		
	AC Mean	OC Mean	Ratio	AC Mean	OC Mean	Ratio
Education	38.42	60.31	1.57	38.42	60.31	1.57
Upper: Middle School	38.90	55.61	1.43	38.90	55.61	1.43
Lower: Primary School	37.95	65.01	1.71	37.95	65.01	1.71
Health Care	31.28	47.8	1.53	34.97	49.84	1.43
Upper: Third-level Hospital	21.23	35.54	1.67	21.23	35.54	1.67
Middle: Second-level Hospital	22.33	52.96	2.37	22.33	52.96	2.37
Lower: First-level Hospital	50.27	54.91	1.09	50.27	54.91	1.09
Shopping	72.28	80.57	1.11	87.25	89.72	1.03
Upper: Shopping Mall	40.82	59.01	1.45	40.82	59.01	1.45
Middle: Large Supermarket	77.95	86.95	1.12	77.95	86.95	1.12
Lower: Convenience Store	98.08	95.76	0.98	98.08	95.76	0.98
Recreation	62.47	78.58	1.26	61.88	76.96	1.24
Upper: Waterfront	64.79	85.05	1.31	64.79	85.05	1.31
Lower: Park	60.14	72.11	1.2	60.14	72.11	1.20
Transport	59.93	66.75	1.11	66.44	74.94	1.13
Upper: Metro Station	40.41	42.19	1.04	40.41	42.19	1.04
Lower: Bus Stop	79.45	91.32	1.15	79.45	91.32	1.15
Overall Score	52.88	66.8	1.26	56.73	70.60	1.24
Upper+Middle (Weighted)	44.53	59.85	1.34	44.69	59.48	1.33
Lower (Weighted)	60.70	74.54	1.23	65.59	78.77	1.20

Notes:

1. AC = Affordable Housing Community, OC = Other Housing Community.
2. Ratio = the OC mean accessibility divided by the AC mean accessibility.
3. A test for equality of variances was implemented before t values were calculated (Levene 1960).
4. All differences between AC and OC accessibility means are significant at the 1% level, except for Metro Station.
5. This table reports the mean access score for all communities.

We map accessibility scores for all land parcels by type of service in Fig. 2. Overall, outlying suburban neighbourhoods have the least well-equipped services and access to facilities. Spatial accessibility to all kinds of facilities is higher in urban centre areas and lower in outer urban areas. Each type of facility has its own pattern of spatial access. Access to education, health care and recreational facilities differs between the urban centre and suburban areas. The straight-line distance from neighbourhoods to these kinds of facilities in the urban centre is mostly 600m or less, which means residents can easily walk. In contrast, the straight-line distance in most suburban areas is above 1200m and residents find it hard to access health care and education services. Although the disparity in spatial access to transport and shopping facilities is lower, areas in the urban periphery still have much lower access. Because most ACs are found in the urban periphery, access to services in most ACs is much worse than in OCs.

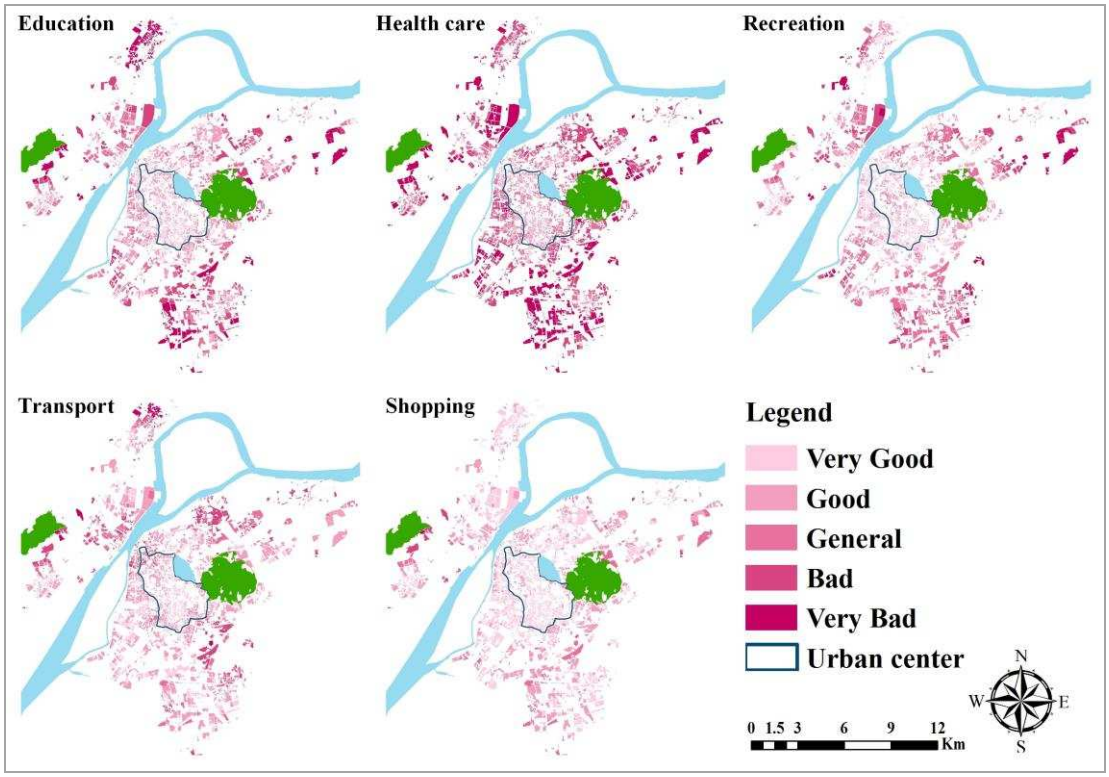

Fig. 2. Spatial patterns of accessibility to service facilities in Nanjing in 2014

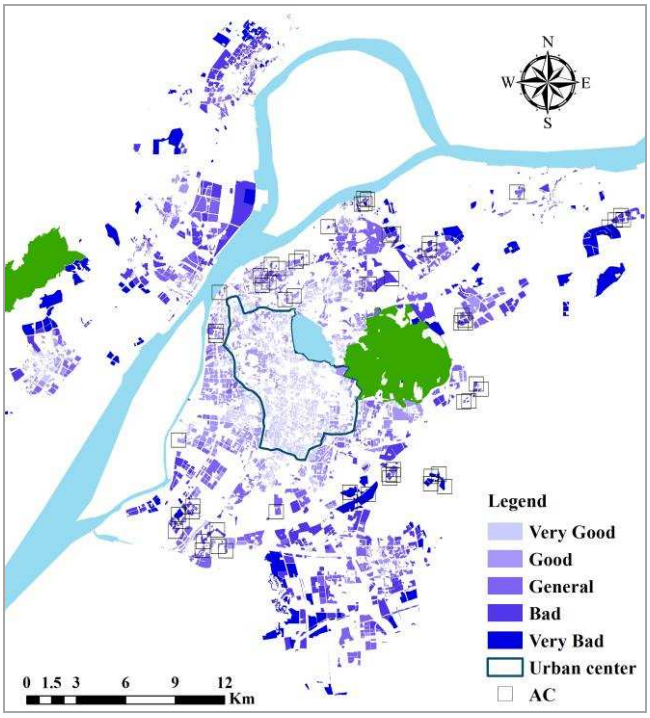

Fig. 3. Average accessibility to five services for the residential neighbourhoods of Nanjing
Notes: 1. AC = Affordable Housing community. 2. Table 3 defines the accessibility categories.

The spatial variation in overall access to services is also significant (Fig. 3). The areas with high accessibility are concentrated in the urban centre. The scores of these places are above 90, meaning easy access to services. The places with the next highest accessibility are found in urban centre areas

or in suburban areas for housing government employees. The scores lie between 70 and 90. Areas with low accessibility are mostly located in the urban periphery. The scores for these places fall below 20, meaning it is very inconvenient to reach community resources. This indicates that most ACs are distributed in areas with low overall access to services.

4.2 The relative accessibility deprivation of Affordable Housing Communities

The built environment influences people's feelings, behaviour and daily lives (Day, 2016; Su et al., 2017). To investigate these impacts, we examine shopping behaviour. Convenience stores, large supermarkets or shopping malls are where people buy food and other daily necessities (Fig. 4). Although Affordable Housing Communities have convenience stores nearby, there is a lack of access to large super-markets and shopping malls. However, the situation in affordable housing is much worse when buying big-ticket items. More than 50% of people living in affordable housing choose large super-markets when buying clothes and over 80% choose shopping malls when purchasing household appliances.

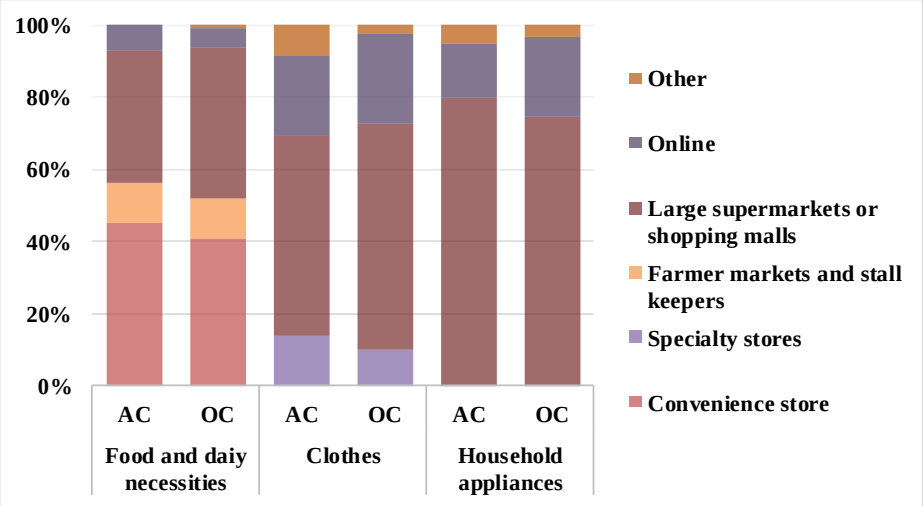

Fig. 4. Shopping channels used by residents of Nanjing communities for different goods, 2014

The disparity between affordable housing and Other Housing Communities is significant in all types of service. Table 8 presents the results of degree of satisfaction with services and the area in ACs and OCs. Results of t-tests indicate the differences are significant. The OC/AC ratios of mean accessibility range from 1.14 (Recreational facilities) to 1.30 (Education facilities). Fig. 5 details these disparities. Fewer residents from ACs than OCs are satisfied with community service facilities. The degree of satisfaction with health care and education facilities are the lower for AC residents: 21.8% are dissatisfied and 19.5% very dissatisfied. The quality of clinics and education facilities accessible to AC residents is lower than those accessible to OC residents. One resident explains her problems of gaining access to health care: *"There is a clinic near the community. If you have a minor illness such* as cold, you can go to the clinic. If you have a little bit serious illness, you should go to big hospitals. But the hospitals ar*e far from here. It's not convenient." (Yinlonghuayuan, female, 45).* Maqun middle school is located near Baishuiqiancheng community, a typical affordable housing community in Nanjing, but many residents still hope their children can go to better schools in city centre. A resident explains thus: *"The school nearby is not good. It can't be compared with elite schools in city center. The rich people all send their children to good schools there."* (Baishuiqiancheng, male, 38). Some

16.1% of residents from ACs are dissatisfied or very dissatisfied with shopping facilities. Although the local government takes service facilities into consideration when planning the affordable community, it appears they fail to meet the demands of residents.

Table 8

Satisfaction with services of communities in Affordable housing and Other Housing Communities, Nanjing, 2014

Service or community indicators	AC Mean	AC St Dev	OC Mean	OC St Dev	Ratio	t	P
Shopping facilities	3.14	.761	3.69	.801	1.18	-5.744	.000
Education facilities	3.08	.766	3.76	.777	1.22	-7.119	.000
Health Care facilities	3.06	.753	3.60	.856	1.18	5.678	.000
Recreational facilities	3.09	.721	3.46	.869	1.12	-3.955	.000
Transport facilities	3.53	.896	3.83	.766	1.08	-2.752	.007
Community living space	3.23	.883	3.84	.833	1.19	-5.829	.000
Community attachment	1.93	.574	2.11	.601	1.09	-2.403	.017
Live in current community?	1.38	.592	1.84	.563	1.33	-6.420	.000

Notes:
1. AC = Affordable Housing communities, OC = Other Housing Communities.
2. Ratio = the OC mean satisfaction divided by the AC mean satisfaction.
3. The Levene (1960) Test for equality of variances was implemented before t values were calculated.
4. .000 = probability of being wrong in rejecting the null hypothesis that the two scores are the same.
5. Respondents are asked to choose one of five satisfaction scores ranging from very dissatisfied (score of 1), dissatisfied (2), neither satisfied nor dissatisfied (3), satisfied (4) and very satisfied (5). Average scores are computed for respondents in AC and OC neighbourhoods surveyed. The higher the mean, the higher the satisfaction feeling.

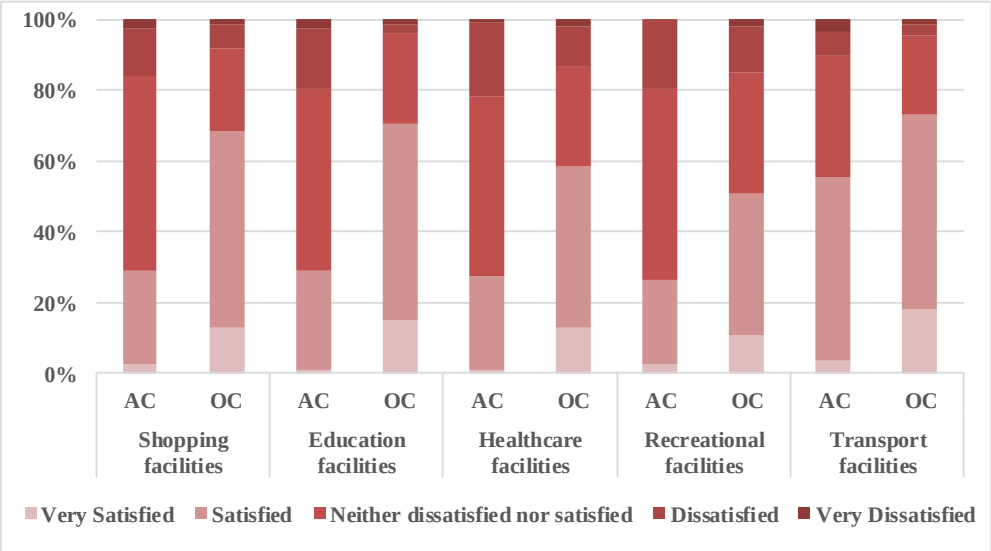

Fig. 5. The distribution of scores for satisfaction of residents from different communities, Nanjing, 2014

There are many resettled residents living in ACs who used to live in the urban centre and other urban areas. They express dissatisfaction with daily life after relocation: "I used to live in Zhonghuamen, it is very convenient there. But we were relocated here, because our previous community was dismantled by the government. We got to the *'rural'* from city at a blow. The daily life *is much less convenient than before. If I have a chance, I must move back to the inner city."* (Baishuiqiancheng, female, 65). Another respondent who used to farm voices dissatisfaction: *"*I was a farmer in H*exi. I moved here because of government's* land appropriation ... I fed myself by farming ... *The price of commodities is so high nowadays, and my wife's health is not good. I have to*

take her to the inner city to see the doctor. Our life is worse than before." (Baishuiqiancheng, male, 78).

The dissatisfaction with service facilities impacts the level of satisfaction with community living space and the degree of community attachment. People's desires to stay or move away are affected. The results of the t-tests indicate that the differences in satisfaction with community living space between ACs and OCs are significant (Table 9). Only 30.8% of residents from ACs are satisfied or very satisfied with their current community living space, much lower than satisfaction in Other Housing Communities. Some 20% of residents of ACs feel no attachment to their community, whereas only 11% of residents in Other Housing Communities report no attachment (Table 9).

Table 9

Community living space satisfaction, attachment and location preferences of residents in Affordable housing and Other Housing Communities

Indicators	**ACs**	**OCs**
	%	**%**
Community living space satisfaction		
Very satisfied	1.1	5.8
Satisfied	29.7	62.6
Neither satisfied nor dissatisfied	47.3	27.1
Dissatisfied	18.7	3.2
Very dissatisfied	3.3	1.3
Community Attachment		
Strong attachment	13.2	20.7
Some attachment	67.0	68.3
No attachment	19.8	11.0
Whether or not want to live in current community		
Yes	29.1	68.4
No	70.9	31.6

Notes: AC = Affordable Housing communities, OC = Other Housing Communities

Only 29% of residents from ACs want to live in their current community permanently. One respondent expresses this view and feels trapped in the community: *"I* have no attachment to this community. At the beginning, I was just unwilling to move here. After arriving here, we found there were no decent hospitals and schools ... I am definitely unwilling to live here all the time. But I have *to live here even if I don't want to live here. Or else, where can I live? There is really no way."* (Yinlonghuayuan, female, 56). Residents in OCs take a more positive view with 68% wishing to live in their current community (Table 9).

Thus, a model grounded in the evidence of the twin analyses of access to services and attitude/satisfaction with services and community can be constructed (Fig. 6). Currently, local governments locate large-scale affordable housing projects in the urban fringes, which gives residents poor access to services, such as shopping, education, health care and recreational service facilities. The poor location makes it difficult and expensive for low-income households in affordable housing to shop, see a doctor and to obtain good education for their children. These difficulties in turn impact

the capacity of residents to improve their lives. For instance, poor access to shopping and health care services could prevent low-income residents getting good-quality food and health care and worsens their health. Poor access to education services may impact children's achievements, which reduces their opportunity for upward social mobility. Although there is no direct analysis of the correlation between accessibility score and health status or children's achievements in this research, there is some evidence of a concern with quality of service facilities in the survey responses. For example: "*You'd* better not get sick. It is not convenient here. If you are ill, it really affects you... Some old men, who play cards with me, are bothered to go to see the doctor and delay their illness. Their children do not care for *them either…alas…"* (Baishuiqiancheng, male, 65). *"The school nearby is not good…The* competition is so *fierce nowadays. If you don't send your kid to good schools, it is hard for him to* attend good university and have good jobs*." (Baishuiqiancheng, male, 38).*

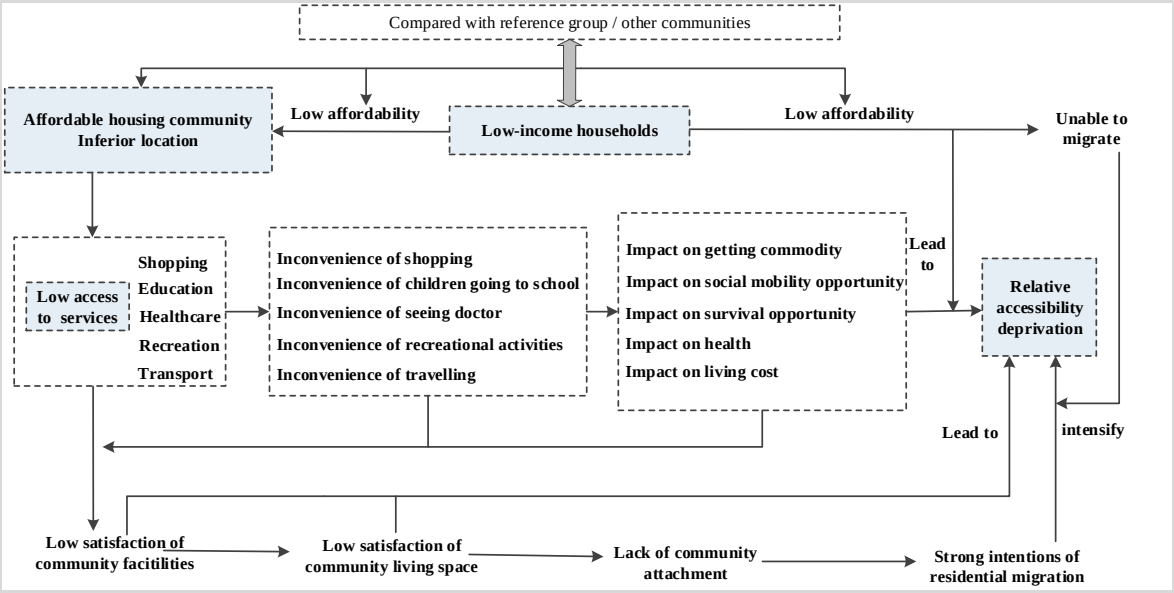

Fig. 6. A model showing how poor location and low income leads to relative accessibility deprivation

Poor access to services with its impact on daily life leads to residents' low satisfaction with services and the community where they live. The formation of community attachment is hindered and there is a desire to migrate to better communities. Even if low-income households are dissatisfied with their current community and want to leave, they cannot do anything about this as they cannot afford to buy or rent elsewhere. Fig.6 summarises the pathways for affordable housing residents that lead from poverty through low accessibility to services, to consequences in daily life and to feelings of dissatisfaction with their communities. The diagram encapsulates the concept of relative accessibility deprivation.

5 Discussion

Affordable housing is an important solution to low-income households' residential problems. In many developed countries, a policy of providing Affordable Housing Communities has been abandoned in favour of subsidising households instead of housing units (Fenton et al., 2013; Ball, 2016; Varady & Matos, 2017). However, the peripheral locations of new-built affordable housing and the relocation of

residents of centrally located housing estates, which have been redeveloped, have led to poor access to services (Apparicio & Séguin 2006; Zandt & Mhatre, 2009; Woo & Kim, 2016). The Nanjing case exemplifies the consequences of building as many units of affordable housing as soon as possible while neglecting needs beyond adequate shelter. This is a common phenomenon faced by many developing countries/emerging economies, such as China, Brazil and Mexico, where rapid urbanization and increasing inequality occur (Buckley et al., 2016; Libertun de Duren, 2018; Wei & Chiu, 2018; Ma et al., 2018). Although low-income households are being provided with reasonable housing, they suffer problems caused by the inaccessible location of affordable housing. The findings of this research demonstrate that the poor location of ACs lead to new social-spatial problems of poor access to services. The results of our study also indicate that low-income households suffer from relative accessibility deprivation, which previous studies have usually ignored. Poor residents in affordable housing may face a poor quality of life and long-term deprivation of opportunities. Inferior access to services influences the poor more than other groups, since low-income households have difficulty in funding trips. Although some ACs also have good accessibility while some OCs have poor accessibility, residents in OCs have better resources facilitating mobility than residents in ACs, which can offset the impact of low access. For example, our survey showed that only 34% of the households in ACs have private cars, compared with 58% in OCs. Households without access to a car living in localities with poor access to services face a "double jeopardy" (Pearce et al., 2006). Meanwhile, nearly 90% households in OCs have household incomes above 5000 yuan, compare with 65% in ACs. Residents in OCs can afford to pay fares on public transport. Therefore, service facilities need to be located closer to ACs or poorer households need transportation subsidies.

Another issue is that affordable housing may be built not only for low-income households, but also targeted at middle-income households, as in China’s Economic and Comfortable Housing program. However, residents from affordable housing community are still relatively poorer than residents in other communities. The poor access to services in affordable housing communities will cause inconvenience and high living costs and impact the opportunities of residents, especially in low-income households. This will lead to relative accessibility deprivation.

This study uses a methodology that combines spatial analysis and household survey, providing quantitative assessment of city-wide accessibility together with a survey analysis of the problems faced by residents of Affordable Housing Communities. This combination has been attempted in few previous studies. We believe that this mixed methods approach will help improve understanding of the social-spatial problems of poor urban residents more clearly. Our analysis of a range of services helped in showing that AC residents face multiple accessibility issues. Our research placed in context the situation of Affordable Housing Community residents by comparing them with Other Housing Communities. These combined approaches can be used for further research into accessibility deprivation in affordable housing projects in other cities around the world.

The findings of this research suggest three policy recommendations for future affordable housing developments in cities.

First, when planning and constructing affordable housing, the governments and commercial developers of ACs should not only ensure decent housing but also offer economic and social

opportunities for poor people – good access to retail services, public services and employment (Mulliner et al., 2013). The main lesson for the local government of Nanjing is that it should plan and provide services very soon after new affordable housing is built. This lesson is applicable to all Chinese cities and to cities in other countries where there is public investment in social housing for poorer residents. It is not a new lesson (Apparicio & Se´guin, 2006; Talen & Koschinsky, 2011; Woo & Kim, 2016) but one that is frequently forgotten. Thus, proper provision of local services and of access via public transport to higher level services should be recognized as a significant component of a successful affordable housing policy (DCLG, 2006).

Second the funding for affordable housing and services should be broadened. In many countries such as China, limited local government budgets are a major challenge to the further development of affordable housing and associated services (Cai et al., 2017). Urban renewal and gentrification supply local governments with substantial land lease fees and enhanced business activity (He, 2007; Wu, 2015). Thus, local governments reserve urban land in good locations for commercial buildings and up-market housing, affordable/social housing tends to be pushed out from inner city (Fenton et al., 2013). Fair allocation of land between commercial and social housing is a crucial issue in planning accessible affordable housing (Cai et al., 2017). Therefore, local governments should diversify the funding sources for building affordable housing. Local governments especially in developing countries could encourage enterprise capital and social capital to invest in affordable housing and supporting facilities. Local governments should also introduce incentives to encourage property developers and social organizations to provide service facilities for the residents of new affordable housing. These incentives might take the form of reduced land lease or administrative fees. However, experience in other cities, for example London, suggests that delivery of such agreements must be carefully monitored and policed (Booth, 2016).

Third, the views of potential AC residents are important for designing better affordable housing projects. The opinions of residents should be consulted on how affordable housing should be built or improved. The planning and construction of affordable housing are usually dominated in China by local governments and developers, without public participation (Wu, 2015). In western Europe, public consultation is usually part of the planning process. But when residents are dissatisfied with the project, they find it difficult to intervene in debates on affordable housing issues other than by complaining or protesting (Jourdan et al., 2013; August, 2016). However, a good planning strategy should aim to distribute resources equitably and achieve normative targets of equity and justice (Fainstein, 2010; Liu et al., 2015; Ouyang et al., 2017). Thus, in the future, the planning process should listen to public preferences and opinions.

More positively, there is evidence of long-term planning in some service sectors which will improve the accessibility of Affordable Housing Communities. For example, the city owned Nanjing Metro company is improving the metro system. Four metro lines are under construction and another eight lines are included in the long-term plan. Several metro lines will pass through or near to Affordable Housing Communities. The new network will improve the accessibility to services for residents of Affordable Housing Communities, provided the price of metro travel is reasonable.

6 Conclusions

For residents of affordable housing, the provision of accessible services is a fundamental concern. Through accessibility analysis supplemented by a survey of residents, this paper has shown that access to all kinds of services in Affordable Housing Communities is significantly lower than that in Other Housing Communities. This results from the inferior location of Affordable Housing Communities in urban fringe areas and the failure of the local planning system to deliver accessible services. The survey of residents indicates that their daily life is impacted by poor access. Low-income households in affordable housing not only suffer the inconvenience of long-distance trips daily, but also have limited opportunities to access good health care and education. Low spatial accessibility leads to dissatisfaction among residents in Affordable Housing Communities, impedes the formation of community attachment and results in a desire to move out. These factors intensify the syndrome of relative accessibility deprivation for low-income households living in Affordable Housing Communities. Therefore, when planning affordable housing projects for low-income households, the locations of and access to community service facilities must be considered by the local government to increase equality and provide liveable, sustainable communities. A shift from exclusive to more inclusive spatial planning, which pays regard to the needs and opinions of disadvantaged residents, is essential for the achievement of spatial justice in Chinese cities.

The study suffers from some limitations. Proximity of a facility does not necessarily mean that a resident in affordable housing will decide to use that facility. The resident may choose a facility which is farther away from their living place. Network distance may be a better measure of spatial accessibility. A future research question, not addressed here, is how the quality of services varies between Affordable Housing Communities and Other Housing Communities. Although the results of this study have indicated that residents from affordable housing are not satisfied with the service quality, further empirical study is needed to examine the differences and to provide more targeted policy suggestions.

Despite these limitations, the approaches employed in this paper have revealed the problem of accessibility deprivation in the Affordable Housing Communities of Chinese cities. The approaches can be used for further research into the accessibility deprivation in affordable housing projects in other cities around the world. Thus, the case can be constructed for urban planning that not only builds housing for low income residents but also provides them with access to quality services at the same time.

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