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Explore the spatial equity of urban public facility allocation based on sustainable development viewpoint

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1 ABSTRACT

The spatial equity of urban public facility is an importance issue in urban sustainable planning development.The achievement of equity in the allocation of urban public facilities is a goal of paramount

importance to urban planners, who must analyze whether and to what degree their allocation is equitable.

Previous studies that have evaluated the serviceability of urban public facilities often employed statistical indices such as total public facilities area, public facilities area per capita, and number of public facilities. However, most of the urban public facilities within Tainan are typically located in the outer areas and thus inconvenient to access. Consequently, frequent opportunities to patron these urban public facilities have been relatively minimal and inequitable. Most spatial equity studies continue to be limited to the use of large-scale aggregate data, which frequently does not capture the micro-scale problems of social groups and neighbourhoods. Use of aggregate data for the evaluation of spatial equity also entails methodological problems—the main one being the ecological fallacy or the modifiable areal unit problem (MAUP). The scale effect of the associated modifiable areal unit problem (MAUP) is also important for the analysis of public facility allocation–spatial equity.

In this study, focuses on the city of Tainan, Taiwan, evaluates the current sustainable policy and proposes facility allocation to achieve a truly spatial equitable , which is compare with two scale and integrated equity indices with which planners can analyze the relative spatial equity of facility allocation are presented, integrating GIS and spatial analysis models , which to improvements in the construction of infrastructure and socio-demographic databases, and help alleviate the MAUP that affects the results of two zone-based spatial analysis.

Finally spatial equity evaluating and the techniques mentioned above in the empirical study, we find that spatial equity of public facilities is more uneven for the aggregated level than for the disaggregated level. Consequently, we must also consider the spatial equity of the entire and individual public facility system. Implications for the sustainability of the city will be analyzed and discussed.

Keywordpp Spatial Equity, Modifiable Areal Unit Problem (MAUP), Geographical Information Systems, Spatial Analysis Models

2 INTRODUCTION

One of the most important issues in the study of spatial equity of urban public facilities allocation is to improve in the quality of the urban environment .(Jones and Kirby, 1982; Kirby et al., 1983; Pinch, 1984; Smith, 1994; Hay, 1995; Talen and Anselin, 1998; Ogryczak, 2000; Omer, 2006). However, planners have been unable to give spatial equity a comprehensive evaluation, for spatial equity has not heretofore been readily operationalizable (Kinman, 1999). Specifically, geographic scale is an integral component in the research on spatial equity. Most spatial equity studies continue to be limited to the use of large-scale aggregate data, which frequently does not capture the micro-scale problems of social groups and neighbourhoods. As a result, a growing body of work has begun to identify the conflict between the local scale, the level where an environmental problem is experienced and is of grassroots interest, and the broader geographic scale, the level at which the discourse of spatial equity can be politically addressed (Harvey, 1996; Kurtz, 2003; Towers, 2000).Besides the geographic scale is an important planning issues of spatial equity, another is most studies usually focuses on only one type of public facility allocation and ignores the relationship between other public facilities, it cannot reveal the inter/intra effects of overall public facilities on urban residents. Furthermore, there has been scant attention paid to the different geographic scale effect of facility service distances and spatial access to facilities opportunities on comprehensive public facilities about spatial equity drawn from previous studies and public facility policies. Consequently, the aim of spatial equity research is to ascertain whether the distribution of public services is equitable and correlates with observed socio-economic spatial patterns (Talen & Anselin, 1998; Omer, 2006).

As any geographical analysis of spatial equity in this context relies on a measure of access to services, it is important to gain an understanding of the sensitivity of the conclusions from conceptualization and measurement of accessibility. Typically, access is loosely defined on the basis of a simple count of facilities or services by some geographical unit, without regard to factors such as spatial externalities, the structure of the transportation network and choice behavior of travellers, the frictional effect of distance, properties of the supply side, and measurement issues related to the large-scale of analysis. Such lack of attention to the regional facility level and neighbourhood facility level are to make different benefit result with the aggregrate data. Furthermore, use of aggregate data for the evaluation of spatial equity also entails methodological problems—the main one being the ecological fallacy or the ‘‘ecological inference problem’’ (Openshaw & Rao, 1995; Wrigley, Holt, Steel, & Tranmer, 1996)—that impact on the reliability of the results. This problem is strongly related to the modifiable areal unit problem (MAUP), which stems from using aggregate data sets at different scales or with different geographical partitions (Griffith, Wong, & Whitfield, 2003; Nakaya, 2000; Openshaw, 1984; P’aez & Scott, 2004; Taylor &Gorard, 2003; Wong, 2003). That is, measurement of spatial distributions according to different numbers of areas or according to different geographical divisions of a given number of areas induces different results. These problems have been extensively aired in the spatial equity literature referring the divergent conclusions reached regarding the extent of spatial inequality of service provision (Glickman, 1994; Greenberg & Cidon, 1997; Sexton, Waller, McMaster, Maldonado, & Adgate, 2002; Talen & Anselin, 1998; Williams, 1999; Willis, Krewski, Jerrett, Goldberg, &Burnett, 2003).

Another focal point of debate is whether spatial access actually affects the probability of use for low-income people. More recently, Ong and Houston (2002) found that single women who were receiving public assistance and did not have a car benefited from transit access. These residents were more likely to be access the facilities than residents with lower level of transit access(Frank Tanser,2006□Hillsdona,2006□Yan Song,2007) .Furthemore, many studie to prove different facility systems that choice behavior of travellers, whether by car, walk, or residential location, had a positive effect on the probability of spatial access to facilities opportunities.Many studies have addressed this question, especially regarding minority and low-income populations (see for example Gandy, 2002; Werna, 1998). Due to improvements in the construction of geographic databases and GIS technology, significant progress has been made toward addressing the issues at hand by making it possible to obtain high-resolution data in urban locations. Two phases can be observed in this processpp the first is collection of high-resolution infrastructure data; the second is collection of high-resolution socio-demographic data. Geo-referenced infrastructure data on the location of urban services, road networks and neighborhood in a city are now available in many countries (Hunter, Wachowic, & Bregt, 2003), enabling precise estimation of origin–destination distances at the neighborhood level, such as the walking distance between neighborhood and facilities. However, infrastructure data are by themselves insufficient to assess spatial equity because when socio-economic and demographic attributes are made available on the basis of aggregate geographical areas, a gap appears between the high-resolution infrastructure data and the aggregate socio-economic data.

Hence, given the technical progress portrayed, the main aim of this paper is to present a methodological framework for using neighborhood-level socio-demographic data in assessing spatial equity as well as to discuss regional facility and neighbourhood facility beneficial implications and potential affect on spatial equity activism. In the next section, a methodology is presented for evaluating neighborhood -level accessibility to urban public facilities based on detailed georeferenced socio-demographic and infrastructure data. Data usability problems with respect to TAINAN Census of Population and neighborhood data are discussed in turn. In the third section, this framework is applied to TAINAN with respect to individuals, social groups and neighbourhoods. Implications of neighborhood -level socio-demographic data for the spatial equity discourse and practice are discussed in the concluding section.

2.1 Spatial equity and accessibility

Researchers of spatial equity dimensions have spanned the social sciences, and their definitions and ambitions have varied, as do the indicators with which they tried to measure the postulated goal (Kunzmann, 1998). For some, spatial equity is just equal access to basic public facilities, measured in distance (Smith, 1994; Talen and Anselin, 1998; Kinman, 1999; Ogryczak, 2000), such as accessibility to school, health

facilities or culture events. For others, spatial equity is more ambitious and would include a choice of jobs and a choice of accessible educational institutions.

Also, it would include a choice of cultural events, not just a local or regional amateur theatre, for different target groups and different age groups (Kunzmann, 1998). Specifically, this paper evaluates the utility of linking the concept of equity with spatial analysis of users at a micro scale, supplemented by an individual resident survey. Here, spatial equity implies that there is an even distribution of services in relation to the needs, preferences and service standards of each resident. This paper recommends a spatial analytical perspective to evaluate suitability of urban public facilities in assessing whether or not, or to what degree, the distribution of urban public facilities is equitable. First, it should be made clear that this paper neither absorbs itself in the so-called equity issues nor does it explore the dimensions of justice, fairness, or propriety in the distribution of travel distances; instead, it addresses relative equity in spatial location of each type of public facility for each inhabitant of the city.The general connotation of spatial equity is that all residents should be equally treated, wherever they live. This idea is, theoretically, an extended form of social equity. Though its definition has varied to some extent, previous studies have generally emphasized the relationship of equity and location (Kunzmann, 1998). In some research, spatial equity may carry broader meanings; for example, it could mean that similar job opportunities are offered to individuals from distinct regions. In the context of urban public facility planning, spatial equity means equal spatial separation from or spatial proximity to public facilities among residents. Of the many available means for measuring spatial equity, accessibility indices have heretofore been the most widely used (Talen and Anselin, 1998).

3 PROPOSED METHODOLOGY

3.1 Study Area

Located in the southeastern corner of Eurasia Taiwan sits in the middle of the Western Pacific festoon of islands. It faces the East China Sea to the north (600 km from the Ryukyu archipelago), the Bashi Channel to the south (350 km from the Philippines), the Taiwan Strait to the west (averaging 200 km from the Chinese mainland), and the Pacific Ocean to the east. Situated at the western rim of the Pacific Basin, the island plays an important role as an East Asian crossroad.These study area Tainan is the forth-grade city in Taiwan, but it's the oldest city which has abundant cultural heritage, as the cultural style presented. Tainan City currently has 6 districtspp Anping, Annan, East, West-Central, South, and North districts. Annan district was originally the An-Shun township of Tainan County, and was merged into Tainan City in 1946. In 2004, Central District and West District were merged into the new West-Central district.

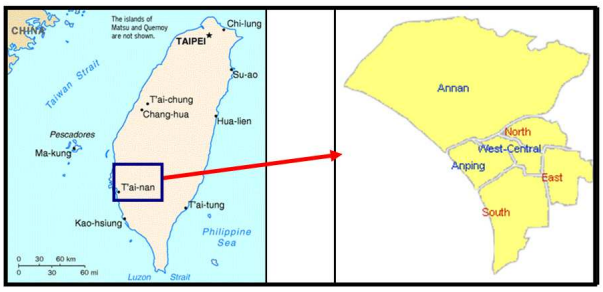


Fig. 1pp Tainan location

3.2 Spatial equity Measuring Method

It is true that different accessibility measures may produce different spatial patterns of accessibility and, depending on the concept of access, the distributional equity of public services may vary . The choice among them depends on the relevant policy questions . Accordingly, the current study considered the characteristics of public service (i.e., public parks) under study, and the features that each of the five most

widely used accessibility modelspp four distance-based models of Gravity Model, Minimum Distance Model, Travel Cost Minimization Model, Container Approach ; and Covering Objectives Model. This study refer to Shen(2005) use the Gravity Model concept was employed for the current study to measure accessibilities of public facility. This measure, called also the facility spatial interaction model, is one of the

simplest, yet most widely used models .We used different level facility system accessibility measures to characterize the spatial structure of the urban facility used opportunities. Each individual's relative spatial position, measured in terms of accessibility to suitable facility opportunities, is determined jointly by residential location and transportation mode. To capture the varia- tions along these two dimensions, we applied the following accessibility measurepp

$$A_i^{auto} = \sum_j \frac{O_{j(t)} \times f\left(C_{ij}^{auto}\right)}{\sum_k \left[\alpha_k W_{k(t)} \times f\left(C_{kj}^{walk}\right) + (1-\alpha) W_{k(t)} \times f\left(C_{kj}^{auto}\right)\right]} \quad \text{.....1}$$

$$A_i^{walk} = \sum_j \frac{O_{j(t)} \times f\left(C_{ij}^{walk}\right)}{\sum_k \left[\alpha_k W_{k(t)} \times f\left(C_{kj}^{walk}\right) + (1-\alpha) W_{k(t)} \times f\left(C_{kj}^{auto}\right)\right]} \quad \text{.....2}$$

A_i^{auto} pp are regional level of facility accessibility for residents who are automobile drivers respectively, living in location i,j = 1, 2, …, N.

A_i^{walk} pp are neighborhood level of facility accessibility for residents who are walk respectively, living in location i, j = 1, 2,…, N.

$O_{j(t)}$ is the number of estimated facility opportunities available in location ; j = 1, 2, …, N

$f\left(C_{ij}auto\right)$ and $f\left(C_{ij}auto\right)$ pp are impedance functions for automobile drivers and walker, respectively, traveling between i and j

α_k is the percentage of households in location k that own at least one car

$W_{k(t)}$ pp is the number of residents living in location k at time t; k = 1, 2,…, N

Urban facility opportunities considered here were benefit in regional facility and neighborhood facility, service. The last two categories are most likely to be suitable for welfare recipients who have relatively different socio-demographic groups.

3.3 Facility Categories and Service Weights

The public facilities in Tainan include 12 types of facility, facilities Service Radius and weights, (Table 2). The public facilities serve those in the main clusters more readily.Numerous medium-sized cities face public facility equity issues as they grow rapidly and are unable to satisfy the needs of their increasing populations.Tainan is a typical growing medium-sized city. It is situated in southwestern Taiwan, covers 175.6456 km², is divided into 243 neighborhoods, and had a total population of about 76,4147 in 2007, a density 4,350.50/ km², and a convenient road network.

Types	Level	Categories	Service Radius (meter)	weights
Sanitary Facilities	Regional level	Hospital	2500	2.5
Amenity facilities	Neighborhood level	Green belts	400	0.4
		Neighborhood parks	600	0.6
	Regional level	Community parks	1600	1.6
		Municipal parks	2400	2.4

Educate failities	Neighborhood level	Elementary schools	600	0.6
		Junior high schools	800	0.8
	Regional level	University	2500	2.5
culture facilities	Neighborhood level	Library	700	0.7
	Regional level	Cultural center	1500	1.5
Prevent facilities	Neighborhood level	Police office	1200	1.2
		Fire bureau	1200	1.2

Table3. Facilities Types and services weights

3.4 Data Sources and Preparation

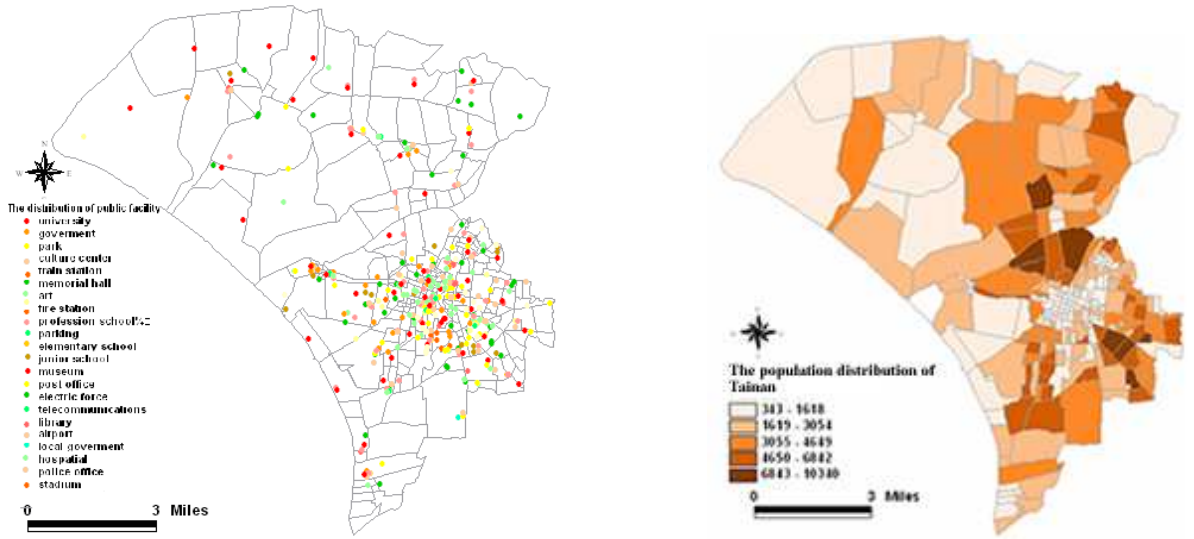
The City of Tainan has comprehensive data sources that make it possible to conduct accessibility and public services utilization studies at a census-based level. The data sets utilized for the current study are from five major sources and facility points and census distribution on neighborhood Districts (see Table 3 and fig2). It is situated in southwestern Taiwan, covers 5077 hectares, is divided into 18 townships, and had a total population of about 66,200 in 2003, served by a national airport, two railway stations, a freeway interchange and a convenient road network.

The primary data sets are mainly GIS lines and their pertinent attribute tables are from the goverment website of Taiwan. (httppp//www.cpami.gov. tw/web/index.php) To enable spatial statistics to be used for analyzing socio-spatial equity, the data for each census unit had to be explicitly associated with that spatial unit in the GIS database. The configuration of the census areas in the census geography is recorded on the CPAMI(Construction And Planning Agency Ministry Of The Interior) of the Census file. The boundary files of the census units are available from selected generalized extracts from the Census Tainan's CPAMI geographic database designed for use in a Geographic Information System (GIS) or similar mapping system, or these files can be downloaded through the ESRI Environmental Systems Research Institute. The spatial and statistically available attribute data were then joined together to form single tables of information within ArcView software.The second data source is the 2007 Census from the Tainan's CPAMI of the Census. The Census data to be utilized in the analysis of the equity of the public facility were obtained from two sources. Most of socio-demographic data for stratifying census tracts and other census units were from the S1 of Census 2007. These were then disaggregated to the level of census block, the smallest census unit available. The remaining economic data, such as median household income, were from the E2 of Census 2007.

Sources	Data	Type	Format
Travis Central Appraisal District (TCAD)	Parcel GIS Attribute Table (owner's name & address)	Table	.dbf file
Austin GIS data set	City Boundary (full) Public facilties .Point (city) Administrative Districts Polygon .shp Neighborhood Districts Polygon.shp Street Center-lines Line .shp	Point .shp lines Line Polygon	.shp
2007 Census CPAMI data	County Boundary Census Tract Boundary Social Groups Boundary	Polygon	.shp

2007Census S1	Socio-demographic data	Table	.dbf file
2007 Census E2	Economic data	Table	.dbf file

Table 2. Data Types and Sources



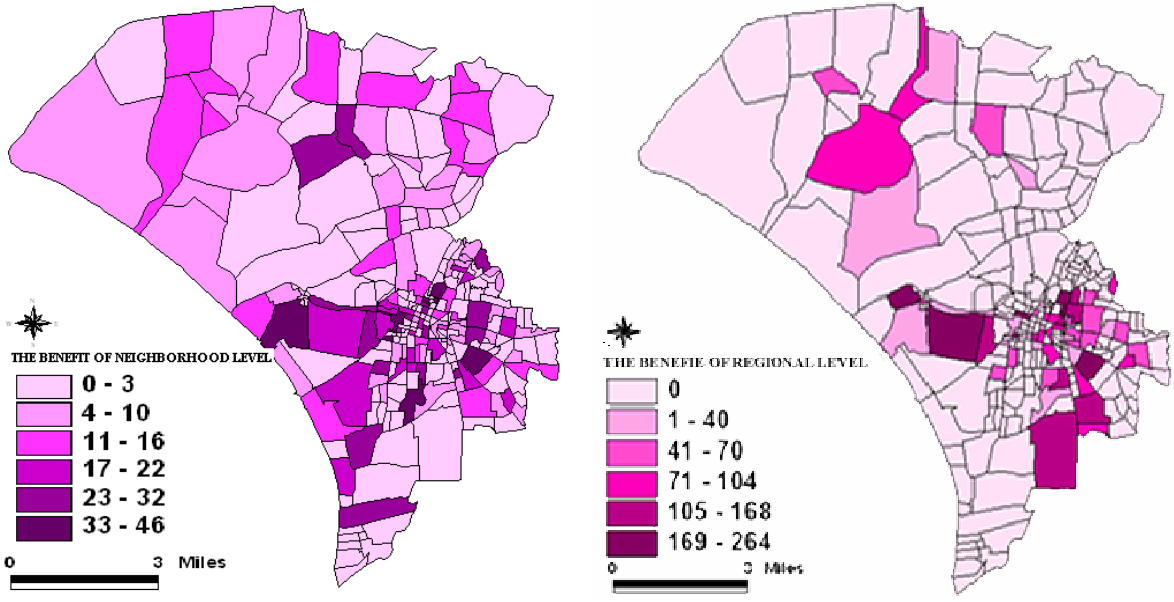
Facility Distribution of TAINAN Population Distribution of TAINAN

Fig. 2 Distribution of Facility points and population pattern in Tainan neighborhoods

4 ANALYSIS RESULTS

4.1 The benefit of different level public facilities analysis

First, we analyze equity of public facilities in Tainan from the point of descriptive statistical of public facilities benefities for each regional facilities and neighborhood facilties levels, respectively With respect to the facilities benefite level, every type of public facility sums obvious spatial inequity, and we find the relatively high quality neighborhood, where have sufficient both the regional and neighborhood facilities. Neverless it can't consider the spatial distance actually affects the probability of use for resident in Fig. 3.

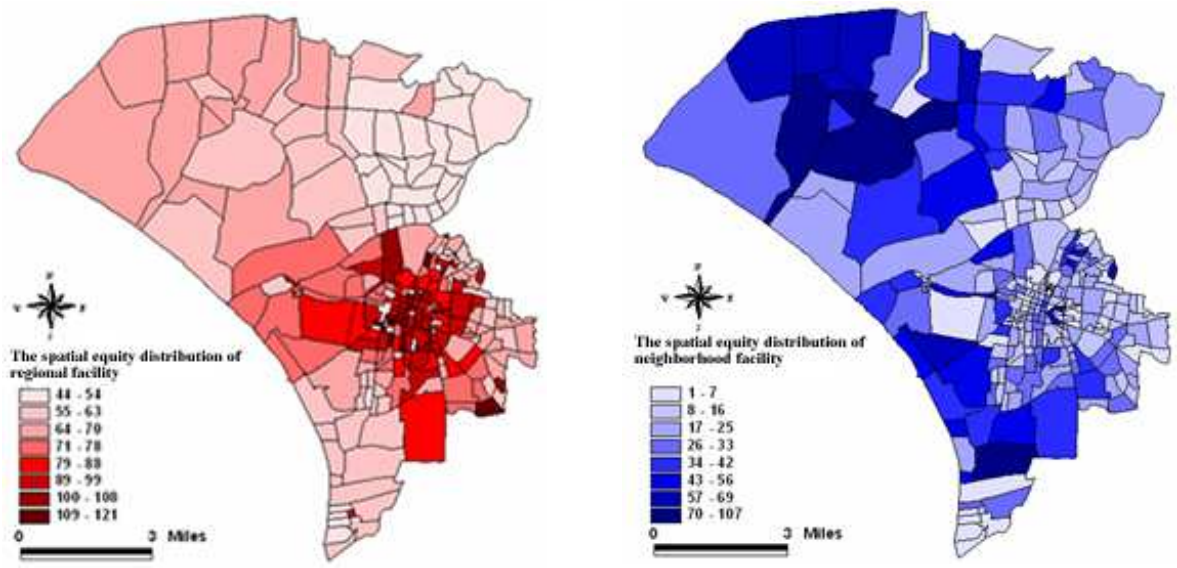


The benefit of neighborhood level The benefit of regional level

Fig.3 The benefit distribution of neighborhood and regional facilities in Tainan

4.2 The spatial equity of different level public facilities analysis

The spatial equity identifies general patterns of accessibility, particularly spatial equity variances and areas with low quality of life. Although employment of such measures can be quite beneficial and even critical when the mapping covers large geographical areas or when the data is highly sensitive, they imply aggregation, which demands concessions to accuracy. This figure shows that the patterns produced by the different public facilities level index are clearer and therefore enable better identification of clusters displaying varying accessibility. Nonetheless, the benefits of aggregation in the context of the right to privacy will be illustrated further below regarding the geographic distribution of income and accessibility in Fig. 4



The spatial equity distribution of regional facilities

The spatial equity distribution of neighborhood facilities

Fig.4 The spatial equity distribution of regional and neighbourhood facilities in Tainan

4.3 The correlation of spatial equity and disadvantaged groups analysis

Previous research in Taiwan has identified clear inequities in public service allocation to disadvantaged groups. The above findings about the differential access by disadvantaged groups identity must considered with caution due to the limitations of the quantitative approach applied in this study.We chose to illustrate evaluation of spatial equity experienced by social disadvantaged variables in Tainan, to analysis the residents with lower level of transit access the different level facility system. In this study, the results shows the maup problem can effect the benefit distribution of the different level facility and the correlation between income and access to nighbourhood level facilities was significantly positive for the criterion amount of spatial equity of neighbourhood facilities (0.422) and significantly negative for the regional level facilities (-.583) in Fig. 5. In the future suggest to sensitivity definition of different level facilities does not consider factors such as facilities type, maintenance, safety, which might influence the quality of spatial inequity.

Social disadvantaged correlation The spatial equity distribution of neighborhood facilities

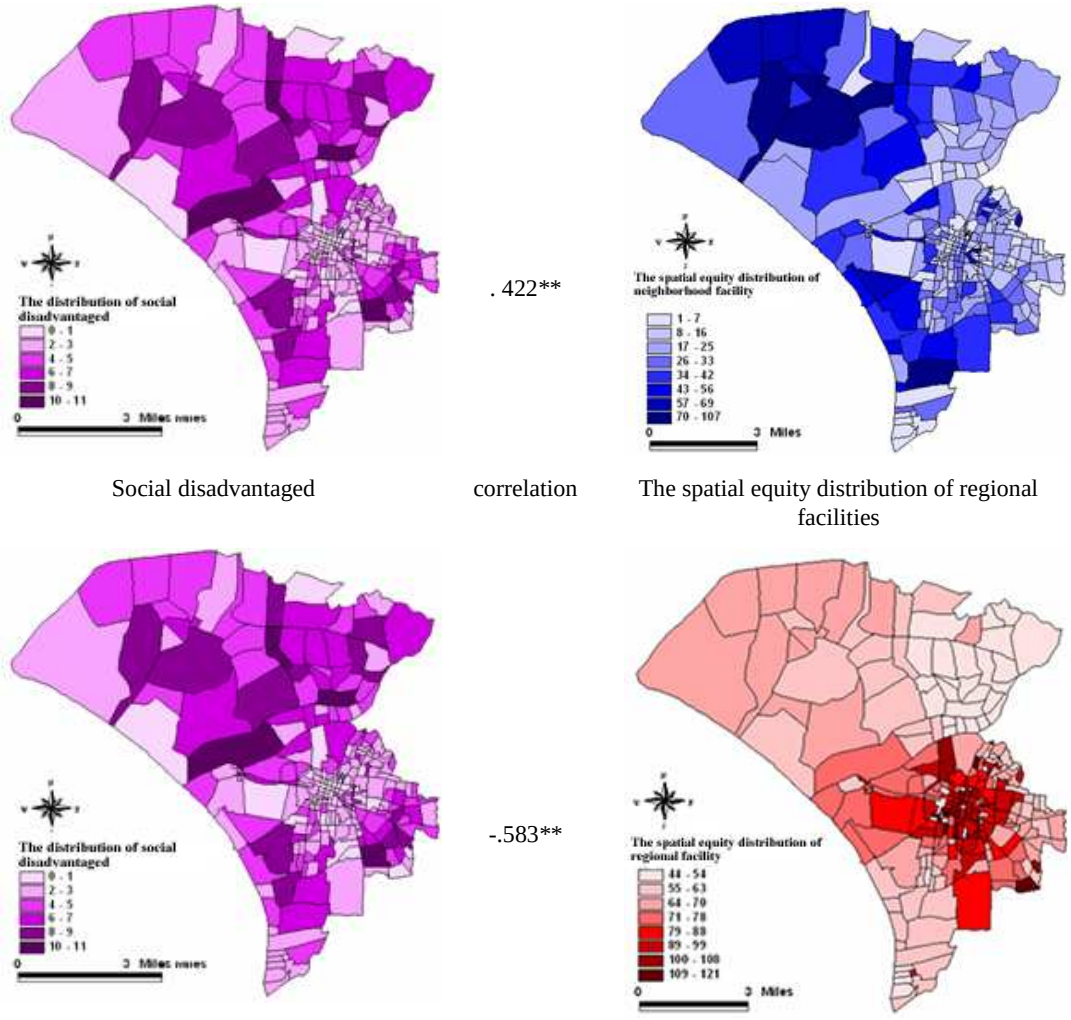


Fig.5 The correlation of spatial equity and social disadvantaged groups in Tainan

5 CONCLUSION

The paper presented a framework for measuring regional level and neighborhood level accessibility of individuals and social groups to public services based on detailed geo-referenced socio-demographic census data. This framework was found to be effective in assessing spatial equity in the provision of different level facilities in the city of Tainan.

It was also found useful for assessing the sensitivity of neighborhoods level and regional-level facility measurements to spatial inequity.The empirical outcomes show that the sensitivity method allows users to easily understand the characteristics of spatial equity in urban public facilities for both neighborhood and regional levels, and to find significant differences between urban public facilities. From accessibility opportunities concept and the techniques mentioned above in the empirical study, we find that spatial equity of public facilities is more uneven for the regional level than for the neighborhood level. Consequently, we must also consider the spatial equity of the entire public facility system. Finally, further research is needed to assess the effectiveness of local-scale information for spatial equity discourse and practice. Improvements in the application of detailed geo-referenced GIS data, together with the development of mechanisms for safeguarding privacy, are likewise necessary.

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