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Extended abstract

1. Theoretical background and aim of the research

The original idea and model of a compact city, which involves mathematical results based on accessibility, is proposed by Danzig and Saaty (1974). Initially, the idea was adopted in urban policy to solve natural environmental problems, and then to solve environmental living problems and social/economic problems in European countries (EC 1990, Kaido 2001, Okabe 2006). The idea of a compact city and those urban policies have also been adopted in Japan since the 1990s. A variety of compact city designs have been proposed by municipalities as new/unique urban structure models during the last two decades. The aims of the designs have changed, and the present aim is to realise sustainable living environments for senior citizens and save finance/administration costs (Morimoto 2011).

Living environments ranging from metropolitan areas and middle-size cities to small towns in Japan still depend on private car use. Although various research studies and urban policy, including compact city design, have proposed that the dependency is serious (for greenhouse gas emission, traffic congestion, poor health or sustainable daily life of senior citizen) and it is necessary to promote alternative traffic modes like bicycles or public transportation, it is reasonable that residents choose how to use their cars/select when to use their cars. Moreover, autonomous driving techniques have developed rapidly in the motor vehicle industry and in IT businesses, and they are also widely demanded in the transportation industry and among private car users.

Urban redesign is required according to those social conditions and the lifestyles of citizens. The aim of this research is to clarify the transformation of urban structure models from the perspective of living environments through examining actual compact city design, and derive the implications for urban redesign given the demographic changes.

2. Methods of analysis

This research summarises the transition of urban policy and design in Japan focusing on typical compact city models, and considering the features related to geographical conditions and accessibility problems calculated by Geographical Information System (GIS). Accessibility is the most important index by which to estimate living environments, and the concept of compact cities is proposed based on accessibility to minimising energy for moving vertically and horizontally (Danzig and Saaty 1974). In addition, accessibility problems are a major concern for local governments in Japan’s ageing society. Almost every city master plan specifies a compact city policy/design to solve such problems.
Analyses of living environments using the accessibility index clarify the effects of compact city design via simulations, and also identify problems based on each type of urban structure. In the case study, two major actual compact city models are compared and analysed. Accessibility is measured mainly according to road networks and public transportation timetables in the daytime. These analyses are manipulated using ESRI ArcGIS software. More details and related analyses can be found in Akimoto (2014a, 2014b, 2016).

3. Transformation of the compact city model

The aim and designs of the compact city vary in different times and areas. Imanishi (2006) identified the adoption, aims, and means by which compact cities are created/achieved through urban policies by surveying 240 municipalities in Japan. A key result was that major parts of municipalities have adopted policies to maintain the infrastructure and recover economic growth in the central area, which is ‘traditionally’ considered a main problem of local governments after the 1960s, the beginning of the age of the automobile in Japan. In other words, most local governments had expected to solve ‘traditional’ problems with the new urban concept of a compact city; however, this aim has not been achieved to date.

The next stage of the compact city policy began in the middle of the 2000s with the emerging problem of living environments under a backdrop of serious demographic changes. All of Japan, including local governments, acknowledged the increasing numbers of mobility-impaired people represented by aged people who would be unable to drive their private cars in the near future. The study also discussed that better city cores could provide a concentration of citizens and urban functions, including services provided by municipalities and private firms. For example, Kachi et al. (2006), using the index of quality of life (QOL) measured by life years, estimated adequate cores to be shrunk the suburbanised areas.

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT 2014) developed compact city models ranging from simple to more general types, which could be applied in every local city; they proposed the keywords ‘compact’ and ‘network’ as part of a national grand design for 2050. However, the concept of an urban policy for a compact city had only appeared for the first time in the white paper of 2013.

Compact city models in Japan can be categorised into 1) centralised types, 2) cluster-types, and 3) networked types. These models are developed below. Local governments have adopted the original compact city policies from the 1990s as indicated in the following case studies.

1) Centralised urban structure

The most famous city of the centralised urban structure type is Aomori City, located in the northern part of the Japanese islands. The city was established as the first compact city in Japan, and the urban model plan is as simple as the construction of the ‘inner-city’, including the central city core, the ‘mid-city’ (suburbanised area), and the ‘outer-city’ (natural area) in the city planning master plan (Aomori City 1999) (Figure 1-a, b). This urban policy prevented new developments in the outer-city from 1999, and also promoted the migration of residents from the outer-city into the inner-city and the mid-city.

The plan is based on the geographical environment of the area, in this case, a heavy snow climate and a plain enclosed by tall mountains in the southern area. Because of these geographical conditions and the urban policy, suburbanisation was constrained at a relatively early stage after 2000. The population of Aomori City is about 300,000 (2015 census) and it is classified as a medium-size Japanese city. Aomori City merged with
another town in 2005, and each municipality now has a compact city policy. Many municipalities located in the northern parts of Japan’s islands have traditionally progressed or adopted compact city policies for snowy climates given the high expenditure required for ploughing snow (MLIT 2009). This is one of main reasons that Aomori City has adopted the policy as a means to realise a more comfortable living environment in an ageing society.

The main means by which Aomori City can realise its compact urban structure is by having residents living in the suburbs migrate into the inner-city and mid-city. Akimoto (2016) analyses the effects of migration in several simulated scenarios according to the Aomori City master plan. As a result, it was found that the impacts are low according to the estimated accessibility index of the city centre, because the percentage of residents in the suburbs is only 16.0% of all citizens, and the percentage of those over 65 years is also only 4.3%. In fact, Aomori City could save large expenditures in maintaining its infrastructure, including snowploughing costs in vast areas of the outer-city, if its migration plan could be achieved. In addition to the main policy, there are two large housing districts in the outer-city and these areas have different needs that must be addressed by the municipality.

2) Cluster-type urban structure

A cluster-type compact city model is proposed in the Toyama City master plan (Toyama City, 2008). This model is based on accessibility by public transportation for mobility-impaired people and senior citizens; the aim of the policy is to maintain their living environment. The central city core and suburban city cores are connected by railways and major bus lines, the urban structure of which would be expected to be polycentric (Figure 2-a, b). To develop this plan, one railway was renewed as light rail transit (LRT) in 2006 and new LRT was constructed in 2009; some social experiments have been conducted to improve public transportation, including bus transit. The policy also expects to promote migration from suburbanised areas into city cores.

Toyama City was established in 2005 out of a merger of seven cities and towns: the main reason for such a polycentric urban structure was to maintain each sub-city core, the central areas of former municipalities. The city is located in the northern area of the middle part of the Japanese islands. The population of Toyama City is about 400,000 (2015 census) and it is also classified as a medium-size Japanese city. The plains extended toward the mountainous southern area, and suburbanisation is at a serious level. The climate is not so severe in the plains, although it snows in winter. Suburbanisation, based on the geographical conditions is also the main reason that Toyama City proposed the original compact city policy. The policy gained considerable attention from other municipalities and the government of Japan.
The urban policy of Toyama City is constituted by the following two measures: 1) improvement of public transportation, and 2) migration from the suburbs to target areas that include the suburban city cores. Akimoto (2014) analyses the effects of those measures in several simulation scenarios according to Toyama City’s master plan. The analyses also calculated accessibility to the city centre and other facilities for daily use, such as supermarkets. The results of transportation and migration simulations indicate different behaviours. The impacts of migration may be low unless the rates of migration are over 50%. On the other hand, the impacts of public transportation improvements may be high as bus frequencies have increased less than five-fold. Although the transportation measures are effective in the short term, the migration measures must be conducted over the middle to long term to identify the wider impacts of the compact city.

3) Networked type urban structure

The networked model is the latest iteration of this type of structure and considered to contain all of the merits proposed in former examples of the current urban design. Although the two former types of compact city model—the centralised type and the cluster type—have already been realised in actual local cities, the networked compact city is only proposed in the city master plan at present. The cluster-type model could be understood as a variation of the networked model, because it contains public transportation networks connecting a central city core and suburban city cores. In general, the networked model has developed those connections and other ICT functions between cities.

Utsunomiya City proposed a ‘network-type’ compact city model (Utsunomiya City 2010), and the reference to the former examples is supposed to have included automobile transit (Figure 3-a, b). However, there were difficulties for the citizens to reach a consensus on the plan to construct LRT, because the feasibility of the proposed costs and effects has been questioned. In addition, the model lacks a network between the sub-cores from the perspective of the strict definition of a networked type compact city.
4. Result and applications for urban redesign

Based on the surveys focusing on the most famous and typical compact city models in Japan, this research proposes the ‘networked polycentric compact city model’ as a general and current urban structure model that has been discussed since the 1990s, and is part of the search for sustainable and efficient living environments given certain demographic changes. Although the networked type appears to be a superior urban model, the costs and benefits connecting sub-cores have not been estimated and the functions have not been discussed. It is easier for citizens to accept such proposals, if the positive effects can be estimated.

This research analyses actual compact city designs mainly according to accessibility, which represents an important index of the living environment. It is meaningless just to compare geometric features and judge which type is superior. For example, the major case studies of Aomori City and Toyama City are frequently compared, and it may be that some research or articles in the media have taken Aomori City to be a failure of compact city policy (Kawakami et al. 2010).

Certainly, the redevelopment around the central station since the 1990s has not been successful in terms of business and an atmosphere of vitality in Aomori City. It also happens that residents living in the suburbs argue against the policy because the local government tries to decrease administrative care for those areas. Regardless of these evaluations, the field survey found that an apartment house built for the aged residents is so in demand by citizens that vacancies are almost zero; moreover, this was located in front of the central station, which is poorly evaluated for urban redevelopment.

On the other hands, Toyama City is considered a successful case by academic researchers and government. However, the geographical conditions and aims of the policy are very different from Aomori City. Toyama City had tram lines and railways at the beginning of the compact city policy, so it was easier to plan the urban redesign using those properties and appeal for information about the success of public transportation. Added to this, the dependency on automobiles and the level of suburbanisation is estimated to be among the worst in Japan, and there are significant problems as to how the main mode of transport—private cars—could be transformed to public transportation.

5. Conclusions

This research reviewed typical models of the compact city in Japan based on case studies taking into account different perspectives (geographical conditions, living environments, accessibility analyses, spatial/geometric features, administrative backgrounds), and proposed the networked polycentric urban structure as a general type of compact city model. Although the model was developed from a simple centralised type
to a complex networked type, the former also has some actual sub-city cores. The polycentric urban model is more useful to apply to actual urban designs, and the type of compact city model should be implemented according to the features of each city, according to effects and costs. Geographical research, including quantitative analyses by GIS and field surveys, could improve the objectives of actual urban redesign from a wider perspective.

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