

# **URBAN STRUCTURE REFORM WITH FUTURE TRANSPORT INFRASTRUCTURES: THE SENDAI METROPOLITAN AREA APPROACH**

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## **ABSTRACT**

Socioeconomic situations in urban areas in Japan have been changing significantly, affected by factors such as decreasing population, ageing society and fewer children, financial restriction, urban deterioration, increasing global environmental burdens, etc. There is a lack of precedents for establishment of a future vision for areas where population is forecasted to decrease or stay constant. In particular, in local cities where the population is forecasted to decrease faster than in larger metropolitan areas, planning, and implementation to tackle the emerging issues is urgently requested. Considering such situations, efforts have been made in the Sendai Metropolitan Area, which is the central metropolitan area in Japan's Tohoku Region, to establish an integrated planning approach for transport and land use and to create an institutional setup for its implementation, instead of using a conventional transport planning approach based on a given future land-use distribution. This paper aims to report a series of developments for this new Sendai Metropolitan Area Approach, focusing on the basic concept, analytical method, planning procedures, institutional setup for the implementation, and the policy measures.

*Keywords: Integrated Land Use and Transport Planning, Urban Structure Reform, Institutional Setup, Implementation Program*

## **1. INTRODUCTION**

It has been widely recognized that integrated planning approaches that consider land use and transport simultaneously are needed to improve transport problems as well as other urban issues. However, there have been few examples of the application of this type of planning except in several metropolitan planning organizations in the U.S.A. The need for an integrated planning approach also applies in most metropolitan areas in Japan. Transport planning in Japan has adopted the 'demand-led' approach, in which transport facilities are designed to accommodate the future expansion of urban areas, assuming a future population increase. Namely, a traditional or conventional transport planning approach based on a travel demand forecast under a given future land-use distribution is generally used.

Socioeconomic situations in urban areas in Japan have been changing significantly, affected by factors such as decreasing population, ageing society and fewer children, financial restriction, urban deterioration, increasing global environmental burdens, and so forth. Because of a lack of precedents, it is hard to establish a future vision in the areas where population is forecasted to decrease or stay constant. In particular, in local cities such as Sendai, where the population is forecasted to decrease faster than in larger metropolitan areas (e.g. the Tokyo Metropolitan Area), the planning and implementation needed to tackle the emerging issues is urgently requested.

Considering such situations, efforts have been conducted in the Sendai Metropolitan Area (SMA), which is the central metropolitan area in the Tohoku Region, in the north part of Japan's main island, to establish an integrated planning approach for transport and land use as well as institutional setup for implementation, instead of using a conventional approach.

This paper aims to report a series of developments for this new approach, the Sendai Metropolitan Area Approach, with a focus on the analytical method, planning procedures, institutional setup for the implementation, and the policy measures. This paper is an extension of Miyamoto, et al (2010).

## **2. BACKGROUND OF THE NEW APPROACH**

### **2.1 Paradigm Change in Transport Planning in Japan**

In traditional urban transport planning, transport provision is the main concern that accompanies the assumption of future urban development. The scope of this relationship can be summarised in Figure 1. Various types of transport developments are discussed with respect to the future enlargement of the built-up area. Since increased levels of congestion and emissions are forecasted, the development of new infrastructures is requested. Along with the infrastructure provisions, maintenance costs are gradually increasing.

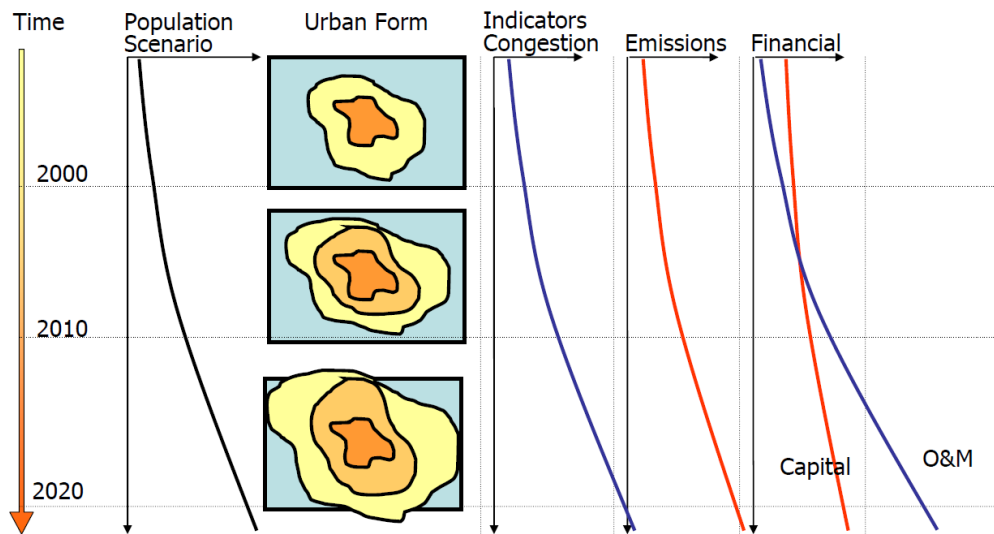


Figure 1 – Scope of urban structure and transport in a traditional paradigm

However, many cities in industrialised countries are faced with fewer children and an ageing society. Cities in Japan are no exception; their population has started to decrease. The situation in local cities is particularly serious. Along with the decrease of population, the total inhabited area will shrink, and isolated residential districts with elderly residents will form (see Figure 2). In addition, aged infrastructure stock is extremely expensive to maintain. These factors will definitely affect the sustainability of the local government’s financial conditions. Urban sustainability in terms of the environment is of course an important issue, but sustainability in terms of public finance of the local government is a more serious and critical problem.

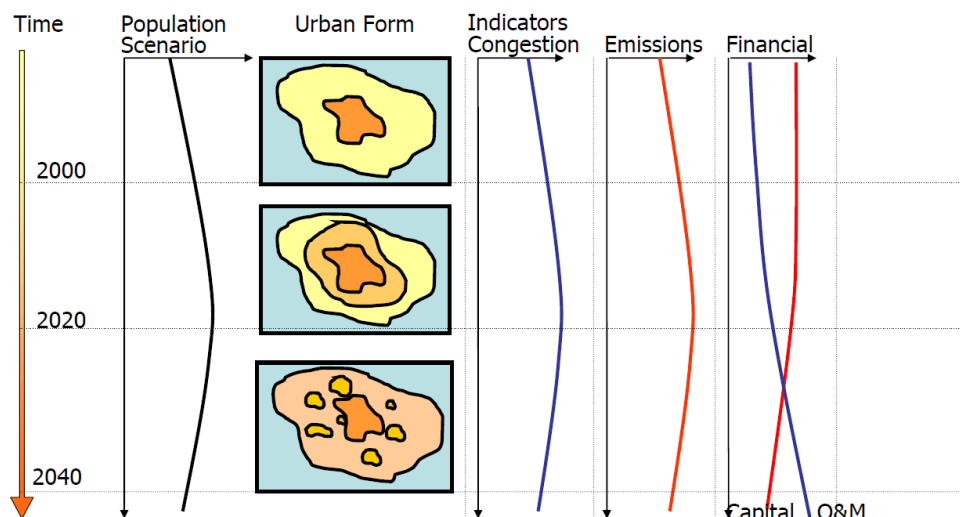


Figure 2 – Scope of urban structure and transport in an emerging paradigm

There are some options in the investment in infrastructure developments in such a metropolitan area as shown in Figure 3. Option A is an ideal one which provides appropriate

infrastructure and adequate cost sharing between generations. Option B is a short-sighted option which will leave under-used infrastructures and debt for the future generation. On the other hand, in Option C no adequate investment is done, and the future generation is left with no monetary debt but with a social cost instead.

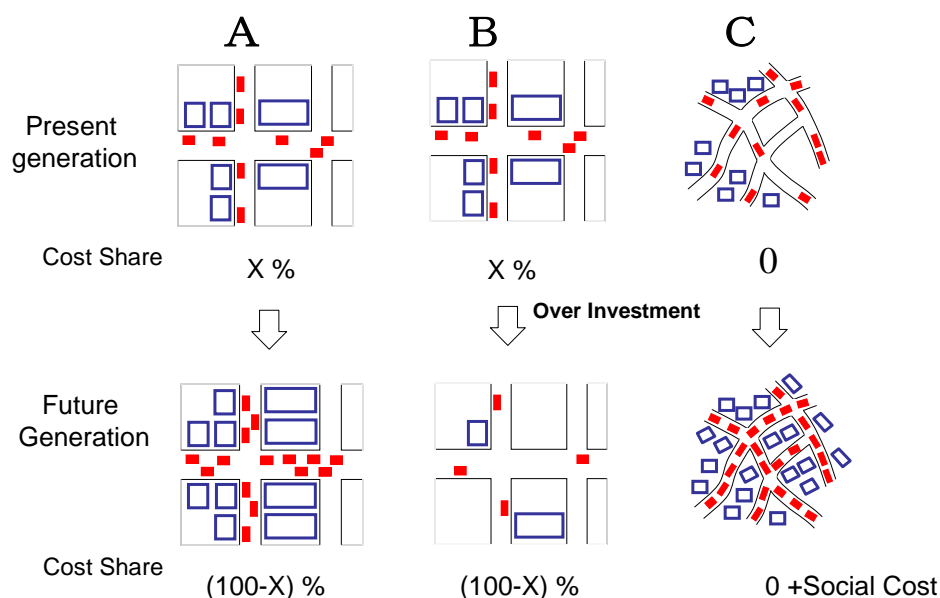


Figure 3 – Options in investment and debt

As considered above, a new approach should be established with a clear idea that the paradigm has been changed in such a metropolitan area. This is the background to devise the Sendai Metropolitan Area approach.

## 2.2 Irrationality in the Traditional Transport Planning Approach

The other reason for a reformed approach is quite obvious but not currently well understood in the field of transport planning. Conventional transport planning adopts a 4-step demand forecasting procedure that comprises trip generation, trip distribution, modal split, and route assignment with a given land-use distribution in the future. However, according to this way of thinking, a traveller looks for a workplace and then selects a transport mode and route after locating his or her housing within a city. This is a very curious theory in view of reality. Therefore, in order to point out the irrationality of this approach, we added questions to the person trip survey sheet that ask respondents about any change of transport mode and route after the present housing had been located. Table 1 shows the percentage of household heads that made a change in transport mode for commuting from what had been planned on before housing location was determined. Only 8 percent of respondents changed transport mode, while 92 percent of people use the same transport mode which they had planned to use.

Table 1 – Change of Transport Mode for Commuting After Location

Transport Mode Assumed Before Location	Number of Respondents	Percentage
Same	2579	92
Different	220	8

(Source: The 4<sup>th</sup> Sendai Metropolitan Area Person Trip Survey)

Table 2 shows the case of route choice for commuting. Only 6 percent of household heads changed their transport route from what they had planned to use before settling on a residential location. Most people are using the mode and route which they planned to use when they looked for their housing, unless they have changed their workplace.

Table 2 – Change of Transport Route for Commuting After Location

Transport Route Assumed Before Location	Number of Respondents	Percentage
Same	2369	94
Different	152	6

(Source: The 4<sup>th</sup> Sendai Metropolitan Area Person Trip Survey)

Thus, the transport mode and route choice is nothing but a problem of residential location choice. Anybody who lives far from a railway station or bus stop will never use public transport. The traditional approach took a wrong path toward a fundamental solution of the problem. Therefore, the Sendai Metropolitan Area Approach (SMAA) is generated.

### **2.3 Existing Attempts of Integrating Land Use in Transportation Planning**

The experiences of integrating land use and transportation planning, decision-making, and project implementation mostly in north America are assembled in “Tool Kit for Integrating Land Use and Transportation Decision-Making”(United States Department of Transportation,2010) and “Smart Land use”(Victoria Transport Policy Institute, 2010).

One of the common countermeasures is the Transit Oriented Development (TOD) program. It attempts to design and develop compact and walkable communities with the public transportation system (mainly rail-transit) as its core function and enables high-quality lives without depending on cars (TransitOrientedDevelopment.org, 2010). Developing compact and walkable communities with rail-transit accessibilities for a certain population density significantly reduces driving and thus the consumption of fossil fuels. TOD is believed to be an effective measure against serious issues such as the escalating crude oil consumption and global warming. However, according to New Urbanism5), the TOD measure has no clear definition or outcome indices; thus, the results are still uncertain. Since no standard or system has been developed for TOD, successful practices have been considered outstanding exceptions that other communities or developers would be unable to achieve. New Urbanism also states that the best practices of TOD need to be integrated since it

requires various stakeholder involvements and their harmonization. The New Transit Town – Best Practices in Transit-Oriented Development” edited by Dittmer and Ohland (2004), outlines the concepts, stakeholders, and related measures of TOD. In addition, the City of Austin (2006) created a Transit-Oriented Development Guidebook that includes the definition, objectives, detailed land use plan, infrastructure design, and design principles of TOD.

Illinois Tomorrow: Corridor Planning Grant Program (2010) supports planning activities that promote the integration of land use, transportation, and infrastructure facility in transportation corridors in Illinois by funding \$15 million for five years to its counties and local governments in urban areas. In Albany County, New York, the Community and Transportation Linkage Program by the Capital District Transportation Committee (2010) help to integrate land use and transportation decisions by providing CDTC staff or private consultant support to local community planning initiatives. Portland has its distinguished integrated plan of land use and transportation, the Region 2040 (Metro, 2010). It examines urban growth scenarios that combine land use and the transportation network to achieve “Smart Growth” from the perspective of the regional government. The final report of the plan was made public and adopted as the “2040 Growth Concept” after consensus building processes.

### **3. THE SENDAI METROPOLITAN AREA APPROACH: CONCEPT AND BACKGROUND**

#### **3.1 Development of the Sendai Metropolitan Area Approach**

In the Sendai Metropolitan Area the conventional transport planning approach with land use as its precondition had been considered in former plans. However, it was found that such a traditional approach would not work in the SMA’s current circumstances. A new approach has been proposed in transport development planning based on population dynamics, financial constraints, and so forth of the area and, in particular, on land use balanced with available transport infrastructures. This approach is the reverse of the conventional approach: land use is the basis for planning with transport infrastructures as given conditions. In order to make the approach feasible, a council to coordinate stakeholders was established that includes local authorities and transport operators and is headed by the Miyagi prefectural government.

The characteristic aims of the approach for the SMA are listed as follows:

1. To consider interactions between land use and transport and to examine policy measures for fundamental issues in land use and transport fields with a comprehensive perspective.
2. To integrate transport and land use plans in the SMA in an organic fashion. Both plans are to be updated every 10 years with a 5-year gap.
3. To propose feasible plans that reflect social and fiscal conditions such as population dynamics, financial constraints and so forth.

4. To adopt urban structural improvement as a primary objective in transport planning and to implement the measures and organizational structure needed to realize any improvements.
5. To establish a coordinating organization to resolve conflicts of interest and build consensus between Sendai city and the surrounding municipalities while providing reliable information.
6. To publicize the guiding principles of the SMAA. Through enthusiastic promotion by the prefectural government to other participating organizations, the principles have been recognized for their relevance to other related SMA projects as well.

Based on the basic concepts listed above, the SMAA can be drawn in Figure 4.

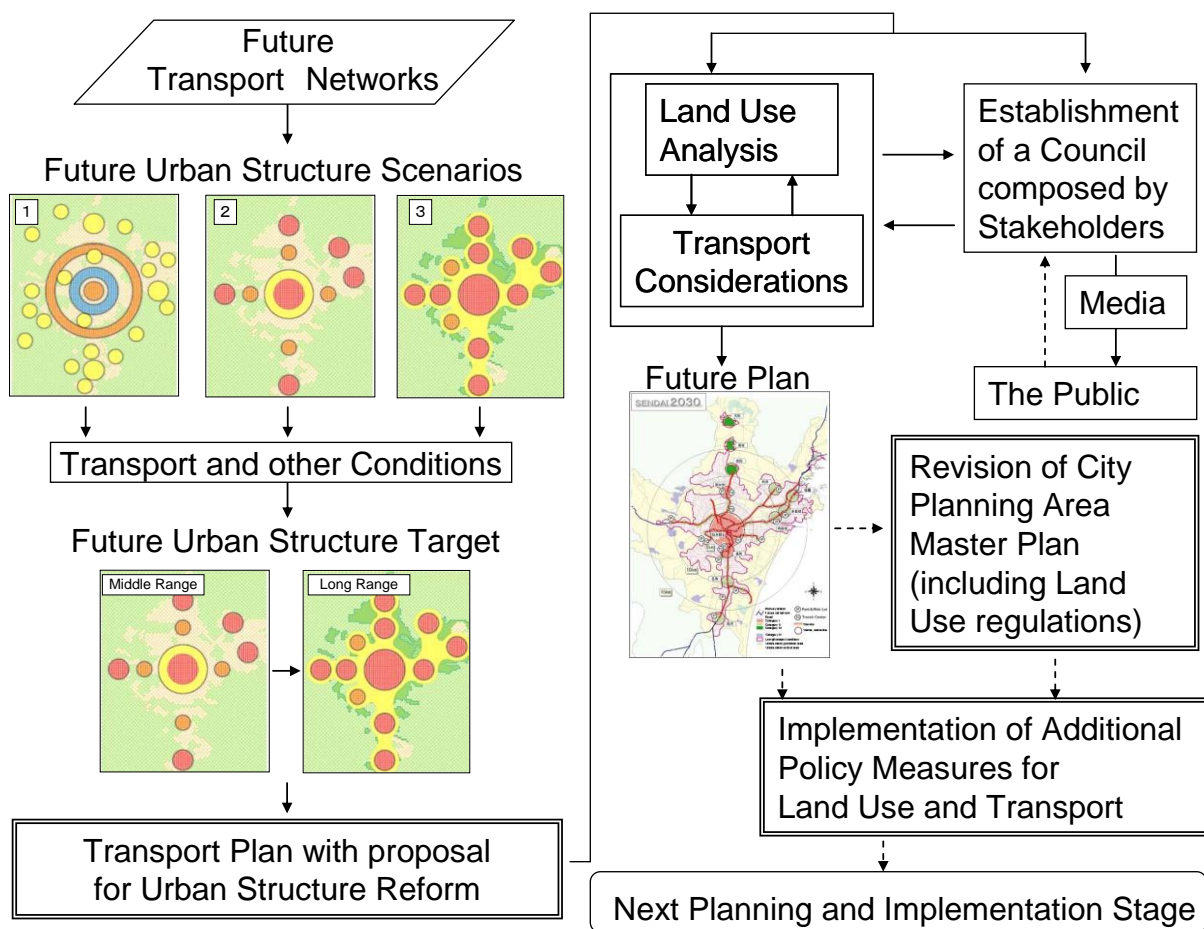


Figure 4 – The outline of the Sendai Metropolitan Area Approach

### 3.2 Basic Concepts of the Sendai Metropolitan Area Approach

#### 3.2.1 From Suburbanization to Consolidated Urban Areas along Corridors

In general, cities have been expanded to handle increasing population. Public facilities (e.g. hospitals, administrative buildings) have moved to suburbs in order to expand the size of buildings and parking areas. As a result, urban areas have extended with low density, causing less profit for public transport and shifting more car-dependent areas.

In 2030, 32 percent of the population in the SMA will be elderly. If current car-dependency continues, the urban centres of cities will deteriorate. Therefore, the prefectural government determined to revitalize the urban area by shifting the structure of the metropolitan area by preventing further urban sprawl and consolidating urban areas on transit corridors.

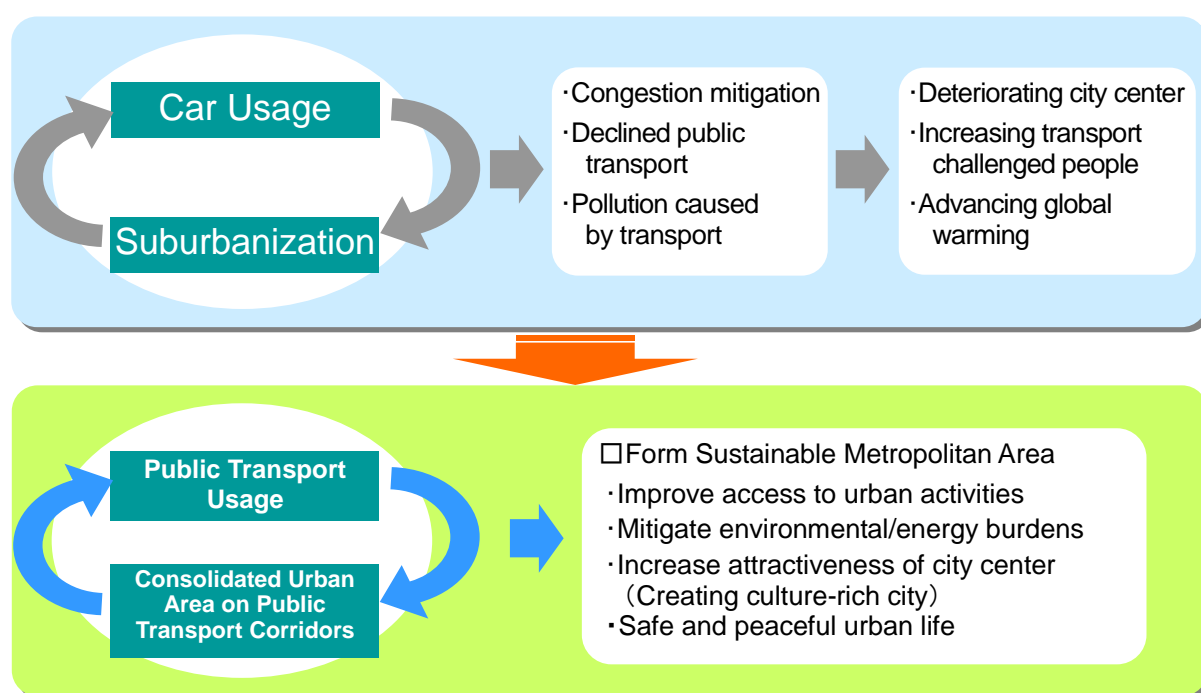


Figure 5 – From suburban expansion to consolidated urban areas along corridors

#### 3.2.2 From Land-Use-Led Development to Integrated Development of Transport and Land Use

Conventional land-use developments with new residential areas have prevailed in the past, but, with expected budget decreases in the future, not as many transport facilities will be built. Therefore, urban development with an approach that integrates transport and land use is really needed. The synchronization of transport measures with land use will be employed through effective use of existing stocks of transit network and urban infrastructure, after announcing feasible urban transport measures.



### **3.3 Background**

#### *3.3.1 Third Sendai Metropolitan Area Person Trip (PT) Survey (1992)*

Based on the 3rd PT survey in 1992, a transport master plan was drafted based on a conventional land use approach that included development of transport facilities and city expansion with several sub-centres. This SMA Master Plan still remains as a long-term plan of transport infrastructures. Yet, the idea of transport demand management (TDM) emerged around this time, utilizing limited infrastructure assets more efficiently to manage the growing demand. The idea was subsequently adapted to control land use.

#### *3.3.2 Fourth Sendai Metropolitan Area PT Survey (2002)*

Reviewing the Sendai Transport Master Plan, there were large gaps between the plan and its achievements in terms of land use and transport facility development. Hence, the conventional approach with a fixed target in land use followed by transport development to handle it was replaced with a new approach. First, feasible transport facility development was planned, then several land use alternatives were generated and evaluated, aimed at subsequent balanced transport and land use. This new approach is discussed in detail later in this paper.

#### *3.3.3 Post- Fourth Sendai Metropolitan Area PT Survey Period*

After the 4th PT survey, many personnel at the City Planning Division of the Miyagi prefectural government who were in charge of the approach to development were transferred to different sections, and the development stalled. The chairman of the Plan Development Committee was concerned about the situation and strongly requested that development continue. Upon this request, new officials at the prefectural government agreed with the needs of both the development and the implementation plans.

#### *3.3.4 Establishment of the Sendai Metropolitan Area Council on Urban Development and Transport*

Upon the decision by the prefecture, the SMA Council on Urban Development and Transport was established and began revising the Urban Planning District Master Plan. The goal of the Council was to turn a 'picture of a rice cake' into a 'real and sweet cake,' as the Japanese proverb says. Today, the Council still aims to realize the plan.

### **3.4 Data**

Data obtained with the City Planning Basic Survey (2007), conducted every 5 years, is used to examine urban infrastructure (e.g. number of residents, population by industry, land-use status by zoning area size etc.). Data for urban activities (person trips) in the SMA is derived from the PT survey conducted every 10 years, with the most recent survey in 2002. The

above two surveys were conducted separately. However, the City Planning Basic Survey in 2007 was conducted with reference to the PT Survey (2002) zoning, so these survey results are related to each other.

## **4. 4TH SENDAI METROPOLITAN AREA PERSON TRIP SURVEY: RESULTS**

### **4.1 Guiding Principles in Examining Urban Transport**

Based on the results of the 2002 SMA PT Survey of 90,000 residents, an urban transport plan was drafted. Following are the guiding principles discussed at the Miyagi Prefecture Council on the PT Survey.

#### **1. Urban structure**

The conventional transport planning approach established merely a single vision for the urban structure, but the Council suggested developing several feasible scenarios of the future. The Council is eager to propose ideas in broad terms, including urban structure.

#### **2. Public Transport**

Public transport could provide sustainable services only if transport is integrated with city planning. Thus, the Council suggested the shift from car use to public transport use.

#### **3. Transport Behaviour**

Selecting a car as an affordable and convenient travel mode adversely affects society, causing congestion and deterioration of the transport environment, aggravating global warming and so forth. It leads to unfavourable conditions for society as a whole. Thus, the Council encouraged citizens to carefully select travel behaviour to mitigate the losses for society as a whole.

#### **4. Budget Constraint**

Due to financial situations such as stifled economic growth and increased mandatory expenditures, significant decrease in transport budgets is inevitable in the near future. Therefore, the Council suggested a feasible transport facility development plan that is within the available financial means.

#### **5. Future Outlook**

Urban structures constantly undergo changes. The Council suggested more flexible policy updates and measure selections in response to circumstances, along with an ongoing understanding of a clearly targeted urban structure and trends in transport.

## 4.2 Scenarios for Urban Structure

Alternative possibilities were developed for transport and land use, which had formerly been considered fixed preconditions. These scenarios defined the path for future transport measures targeting 2025.

### 1. Scenario 1: Low Population Density and Urban Sprawl

Current trends of suburban sprawl with low population density continue, while population decreases in city centres and existing urban areas. People's lives and urban activities depend on cars.

### 2. Scenario 2: Guided Planned Urban Areas

This scenario integrates land use and transport by implementing the current city plan, systematically guiding urban areas, developing viable transport facilities, and practicing regulation, economic and information measures, at the same time.

### 3. Scenario 3: Consolidated Urban Areas on Transit Corridors

This scenario is beyond conventional urban planning. Urban areas are formed by transit oriented development (TOD), in which both urban and everyday activities are located near railway stations, with housing concentrated nearby.

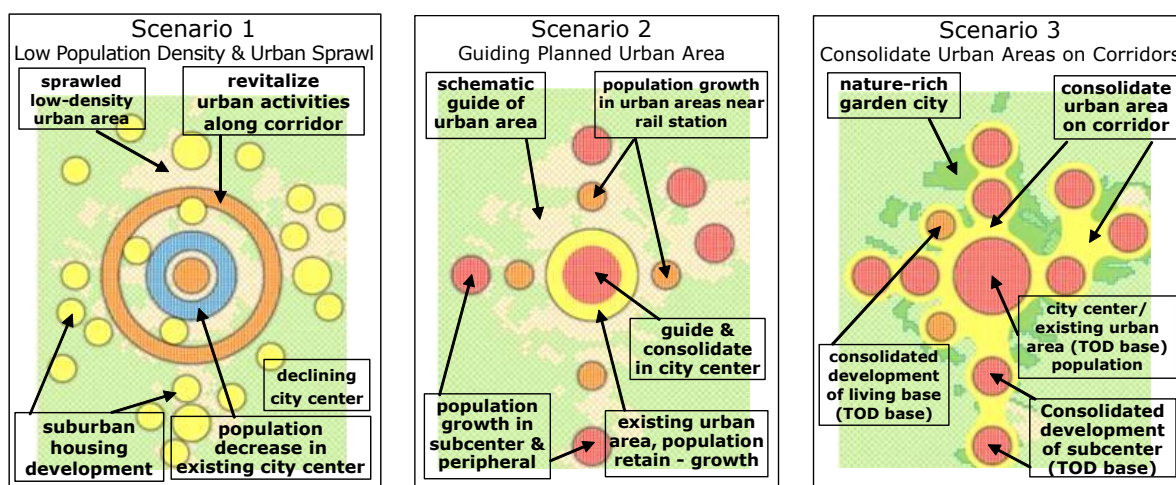


Figure 6 – Overview of three scenarios

## 4.3 Evaluation Results and Targeted Urban Structure

The above scenarios were compared and evaluated. Scenario 1 follows the trend of current urban sprawl which contradicts the guiding principles of the Miyagi Prefecture Council. In

contrast, Scenario 3 fits the principles most closely, and is considered to be a targeted structure for the future. It will require substantial reorganization and intensive development of transport facilities and, therefore, a long period of time to achieve. Scenario 2 could realize some of the improvements of Scenario 3.

Thus, Scenario 3 will not be achieved in 20 years, but it became a long-term vision, while Scenario 2 is considered a mid-term target. The Council decided to 'consolidate urban areas on transit corridors' through coordination of measures for urban area and transport development based on the long-term target. Then, it suggested integrating the following three policies into implementation of the plan:

1. Coordination between transport policies and land-use policies in urban areas where traffic is generated (urban planning policy)
2. Packaged implementation measures: transport facility development and regulation, economic and information measures

Community management through cooperation between transport service providers and citizens/businesses who benefit from the service (community policy)

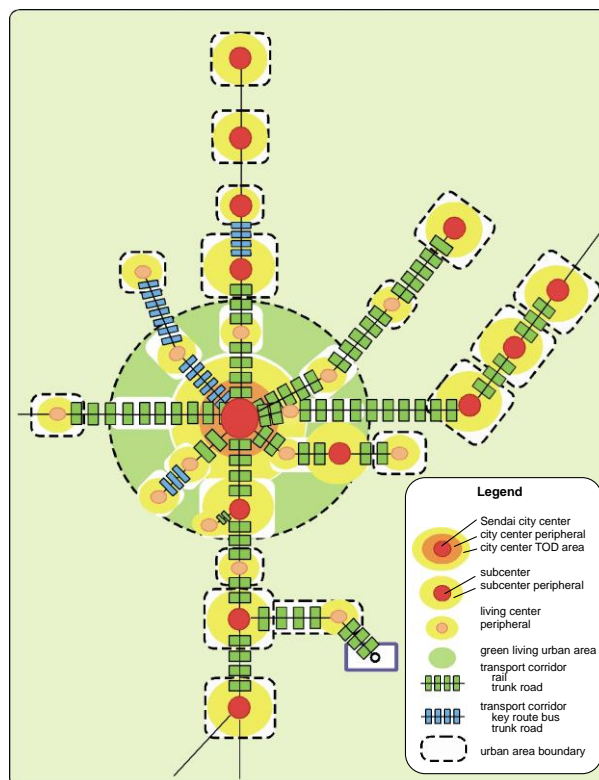


Figure 7 – City structure: consolidated urban areas on transit corridors

## 5. CITY PLANNING AREA MASTER PLAN FOR THE SENDAI-SHIOGAMA REGION

### 5.1 Approach to Reflect City Planning Area Master Plan

#### 5.1.1 Action Taken by the Miyagi Prefectural Government

The Japanese government does not mandate municipalities to formulate a master plan based on the PT survey.

In 2005, the Miyagi prefectural government was about to update the city planning Area Master Plan for the Sendai-Shiogama (Sen-en) Region, mandated by the City Planning Act, under the concept, 'consolidate urban areas on transit corridors.' The City Planning Division of the prefectural government reserved the 2006 budget and began drafting the Area Master Plan for 2007, to reflect the PT survey results.

There are two factors behind this action. First, the City Planning Division became responsible for both transport and land-use measures, which, before the 4th PT survey, had been managed by two different divisions. Second, the official who was in charge of the PT survey also oversaw formulation of the Area Master Plan. This was one of the first integrated planning approaches in Japan, and resulted from this official's decisions and clear vision for the future.

#### 5.1.2 Organization for Regional Coordination and Accountability

Since the concept of consolidating urban areas on transit corridors significantly changes the existing urban structure, regional coordination that shares the guiding principles among municipalities and other interests is critical. In formulating the Area Master Plan, a group of representatives from organizations involved in urban planning and transport planning (i.e. the Ministry of Land Infrastructure, Transport and Tourism, municipalities, non-profit organizations, transport operators, etc.) established the Miyagi Prefecture Council on Urban Development and Transport for regional coordination. The Council consists of 10 local municipalities and the city of Sendai, which plays a central role.

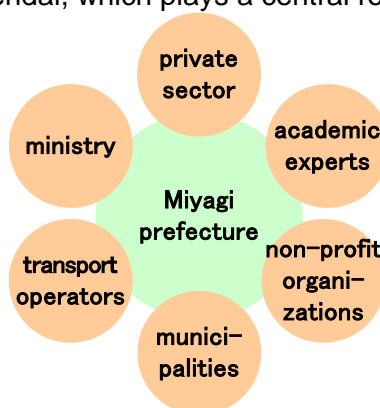


Figure 8 – Members of the Council

There are trade-offs among participants. In planning the entire region and implementation under the guiding principles, coordination among stakeholders is critical: the Council is established to play this coordinating role. A series of discussions at the Council is held with a public audience and is publicized through newspapers, magazines, and other media.

## **5.2 Analysis of Urban Structure With Transport Perspective**

### *5.2.1 Method for Analysis*

To realize the type of urban structure that consolidates urban areas on transit corridors, urban functions need to be gathered in areas with good access to transit corridors. This paper evaluates areas in the SMA and attempts to identify such areas with good transit access and feasible transport facilities.

First, assuming a future feasible transport service (in 2030), indicators of transport accessibility are identified. Then, liveable areas (i.e. areas with good transport access) are identified, considering land use limitations such as for farmland and for the preservation of natural areas.

The analysis contained the following three aspects:

1. Accessibility
  - Areas with good access to economic/commercial centres, urban recreational activities and so forth
2. Land Use Regulation
  - Farmland (area designated for agricultural purposes)
  - Nature (area designated for preservation of the natural environment, forests and natural parkland)
3. Availability of Public Transport
  - Area within a walkable distance (1 km) from a railway station

Accessibility is an indicator of 'attractiveness of destination' from origin, and of 'being near to destination.' In estimating accessibility, the logsum value obtained by a nested logit model with four levels is employed.

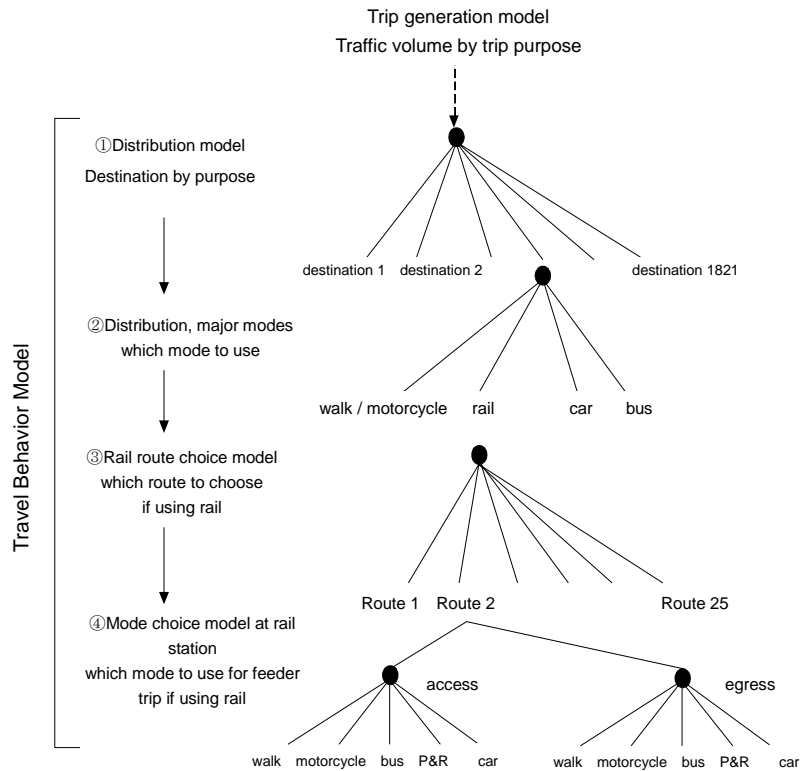


Figure 9 – Logsum function based on destination choice structure

Based on accessibility evaluation and land use regulation for farmland and nature preservation areas, the Sen-en regional city planning areas are identified as conurbation areas with high convenience for living and no land use restriction.

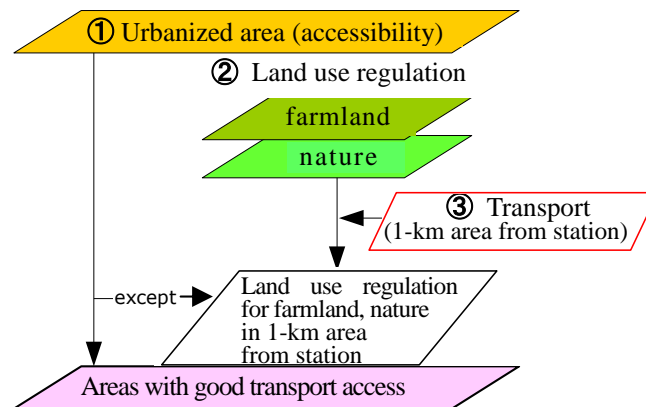


Figure 10 – Evaluation of comprehensive transport conditions

### 5.3 Analysis Results (Basis for Area Master Plan)

#### 5.3.1 Identify Areas with Good Transport Access

'Areas with good transport access' in the Sen-en Region are evaluated with the three criteria described above: urbanized area (accessibility), land-use regulation and transport (see

Figure 10). Such areas include 91 percent of the current urbanization promotion area and 97 percent of the population within that same area. On the other hand, approximately 7,600 ha outside of the urbanization promotion area are evaluated as being areas with good transport access; these areas are mainly within 1 km of a railway station. Basically, the city planning Area Master Plan adopted a principle to identify areas for promoting various infrastructure developments within the areas with good transport access. On the other hand, there are 11 existing urban (residential) areas with poor comprehensive transport in the suburbs (see Figure 11).

Nine of those were developed as housing areas after World War II. Most families that moved into those areas did so at about the same time, and most of the heads of household were then in their 30s to 40s, causing age bias among residents. Therefore, maintaining communities with rapidly ageing populations will be an issue in such areas.

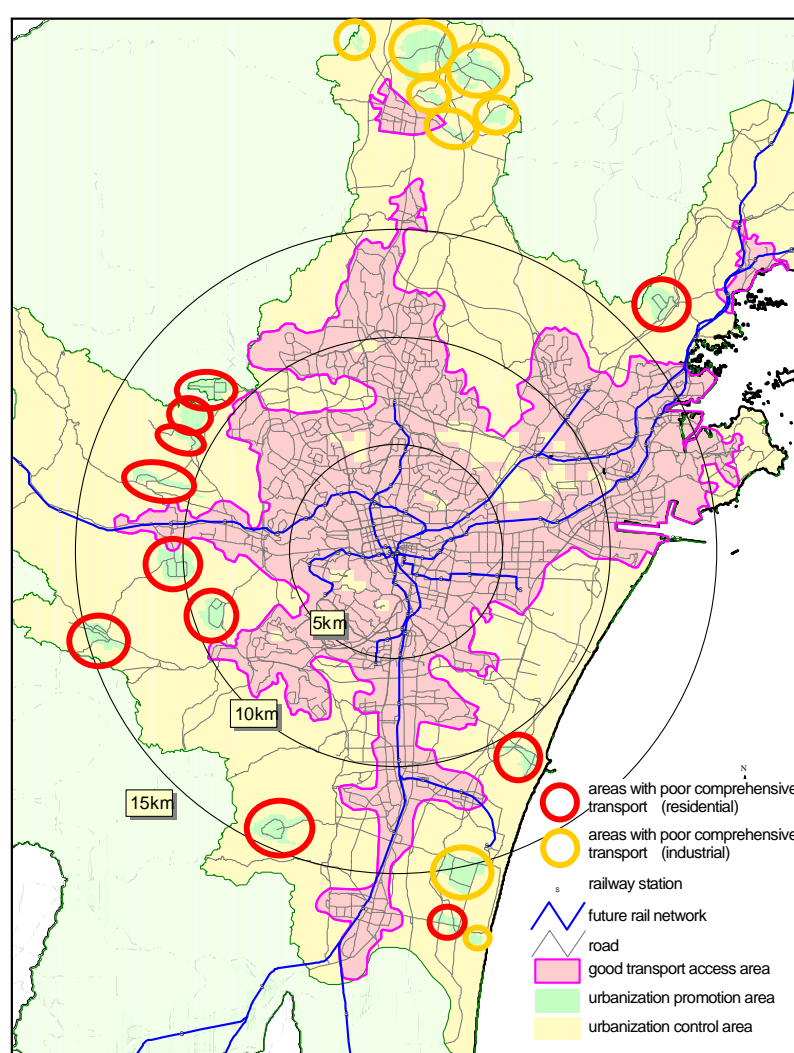


Figure 11 – Areas with poor transport conditions

This map (Figure 11) was publicized in the local Sendai newspaper, and received a lot of responses. This information drew the attention of residents who did not have any clear idea about a lack of transport access in the areas where they live, and it continues to provide



beneficial information to those considering relocation. Providing information is one of the important measures of the SMMA.

### 5.3.2 Consider Transport Measures for Establishing Transit Corridors

Transit corridors are examined to coordinate the above urban structure. Developing bus rapid transit (BRT) is considered for areas outside the railway network. Moreover, measures connecting transit nodes through park and ride bus services for motorists and cyclists are proposed as ways of expanding transit serviced areas.

### 5.3.3 Establish a Vision for the Sendai Metropolitan Area

Results of investigations into areas with good transport access and transit corridors are integrated into the urban structure with consolidated urban areas on transit corridors as part of the vision for the future of the SMA (see Figure 12).

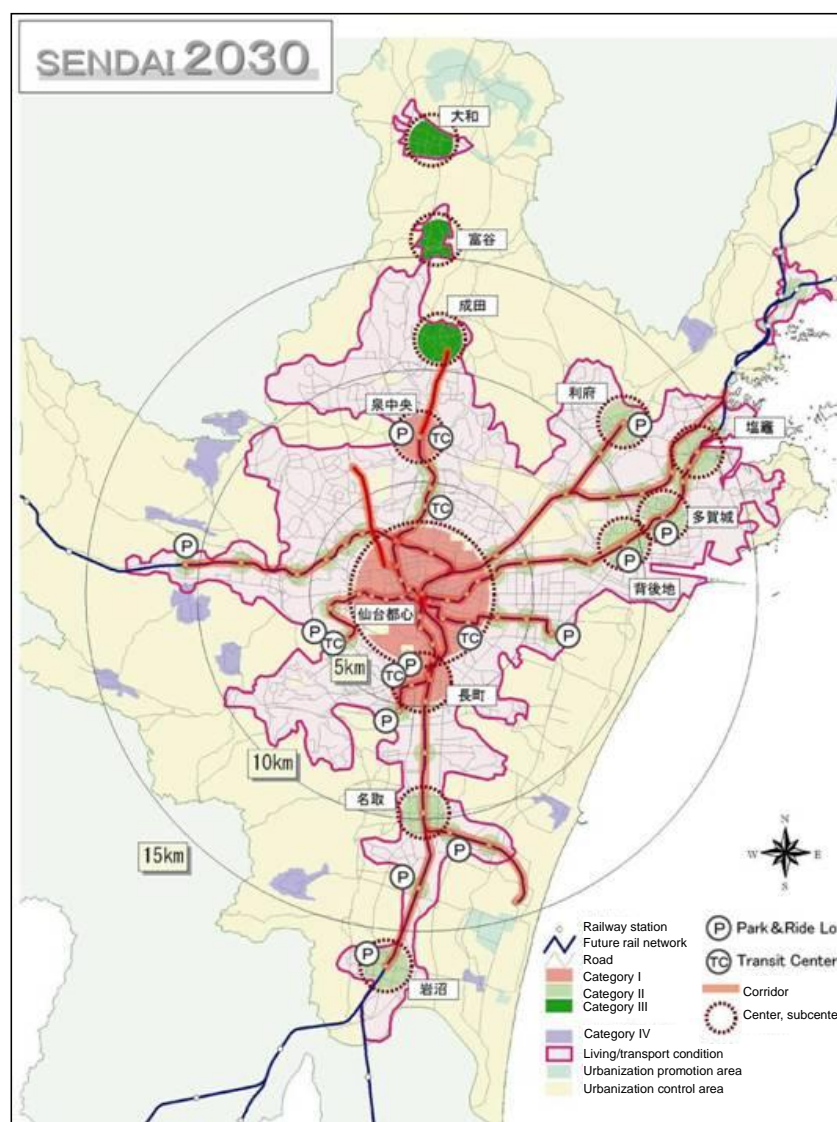


Figure 12 – Proposed land-use plan for revision of land-use mandate

### 5.3.4 Other Measures

The prefectural government advises stakeholders that projects should be conducted according to the guiding principles of the PT survey. A new long-term plan for the city of Sendai, the 'Sendai Vision,' explicitly incorporates these principles. A new subway route, the Tozai (east-west) line is currently being constructed and is expected to open in 2015, as a part of the transit infrastructural network. Besides transit construction, collecting tolls is being considered in some areas to finance the promotion of transit use.

The prefectural government encourages university students and staffs to move to areas along the new subway route since universities attract large crowds. It has already issued trial subway passes to university students.

## 6. CONCLUSION

This paper discussed the integrated planning of transport and land use, and a series of approaches toward its implementation. The results will be reflected in the 2010 Sen-en Regional City Planning Area Master Plan. Detailed measures will be constantly examined through the Council on Urban Development and Transport as well.

The need to examine ideas for future urban structure while contending with population decrease is an issue that the SMA faces along with other local cities. Therefore, recently Japan's Ministry of Land, Infrastructure, Transport and Tourism, while seeking to reduce carbon emissions, has researched integrated approaches to city planning and transport planning for societies facing decreased population. The SMAA is one of the first in the nation to rise to the challenge.

## ACKNOWLEDGEMENT

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