ANALYSIS OF DIVERSION OF SURROUNDING SITES ALONG AN URBAN LINEAR ELEMENT ACCOMPANIED BY ITS USE CONVERSION
- FOCUS ON SAGA LINE OF JAPAN RAILWAY -

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Abstract
Urban linear elements such as roads and railways are important elements of a city's framework. Their abolition or use conversion has a strong influence on the surrounding sites and induces changes to the city. In particular, because a railway connects major districts linearly, the sites surrounding the railway are valuable; however, these sites occasionally have unusual shapes and are inconvenient to use. In this study, we focus on an urban linear element known as the Saga Line of Japan Railway, which was discontinued in 1987 and converted primarily into a road, with a bicycle path in the suburb. Moreover, because the line passes through city blocks diagonally, the sizes and shapes of the surrounding sites have affected the conversion of the land itself. Here, we define the ratio of the shape to a square, because a better organized shape can be used more effectively. As a result, the following points are clarified: 1) permission by a city planning law to develop sites that are less than 1,000 m^2 in size has an influence on their conversion to other uses and 2) in terms of the shape of the site, sites where the ratio of the shape to a square is less than 30% cannot be used effectively. We can conclude that the land uses for sites surrounding a linear element such as the Saga Line are affected by their sizes and shapes, which are produced by the linear element.

Keywords: Discontinued line site, Well-organized shape, Diversion, Use conversion

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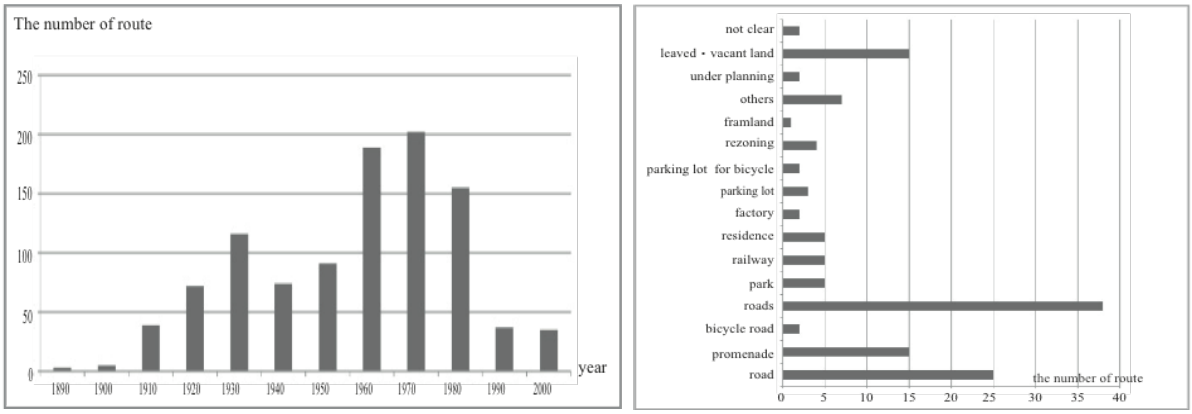


(a) Number of discontinued railway sites

(b) Number of land use conversions from discontinued railwavs

Figure 1: Number of discontinued railways and their conversions.

1. INTRODUCTION

1.1 Research Background

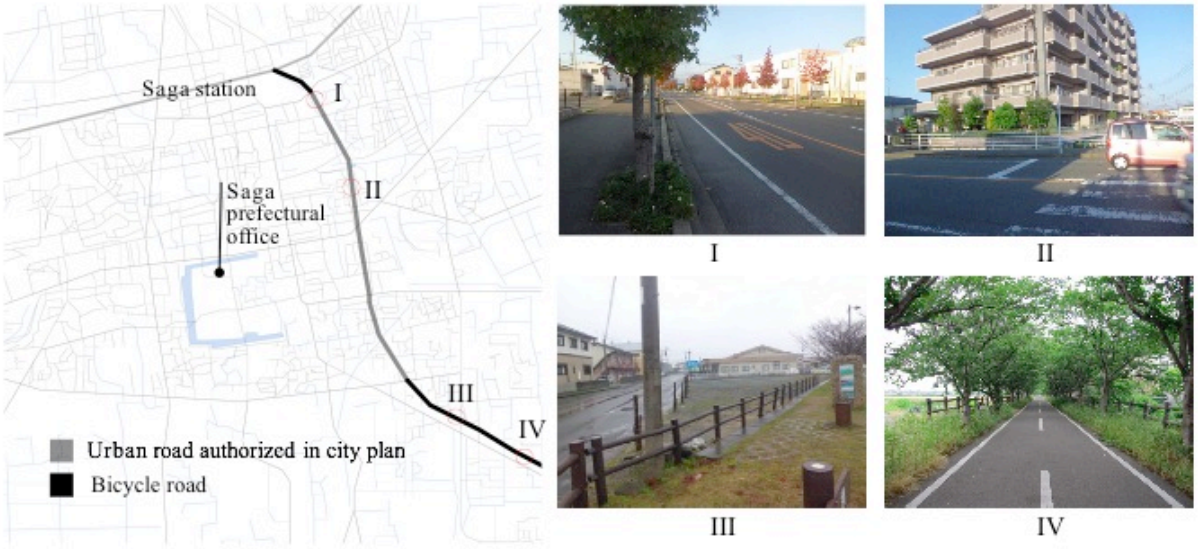
Urban linear elements such as roads and railways are important elements of a city's framework. Consequently, their abolition or use conversion has a strong influence on the surrounding sites and induces changes to the city. A prime example of such an abolition is that of a railway. In recent years, the abolition and conversion of such linear elements have been increasing. The causes for this have been cited as increasing motorization, decline in local population, and financial failure. When a linear element is abolished and converted, its surrounding sites are inevitably affected. In particular, because a railway connects major districts linearly, the sites surrounding a railway are valuable; however, these sites occasionally have unusual shapes and are inconvenient to use. Therefore, it is important to clarify the changes to the surrounding sites that accompany the use conversion of an urban linear element.

1.2 Literature Review

Miyamoto (2007) highlighted the importance of measuring environmental noise to construct a landscape. To this end, some previous studies have considered the conversion of urban linear elements (Kawai and Terauchi 2010, Nojiri and Oosawa 2009). A study on the land use of lots left vacant by disused railway lines (Takahashi and Nakai 2004) clarified that discontinued railway sites are converted mainly into roads, promenades, and bicycle paths.

Some of the previous studies focused on the shapes and sizes of city elements. For example, a fundamental study on triangular-shaped blocks (Ogiso and Inoue 2010) focused on the effect of these distorted blocks in a city. It clarified that a smaller block makes it easier for a building to have a rectangular shape. Moreover, when the block is a sharp triangle in shape, it is easier to construct a building on that block. In contrast, when the block is an obtuse

triangle in shape, constructing a building on that block is more complicated.



(a) Location (b) Photograph of current scenery around the line

Figure 2: Current land use of studied discontinued line.

A literature review showed that some studies have been conducted on a discontinued railway itself, whereas other studies have considered the redevelopment of the national railway property. Some studies have considered sites with irregular shapes (e.g., Okamoto et al. 2006, Murakami and Seguchi 2010). However, the influence on and changes to the sites surrounding an urban linear element after its use conversion have not yet been sufficiently clarified. It is therefore important to focus on urban linear elements such as discontinued railway sites to elucidate how their use conversion influences them, by converting discontinued railways into roads.

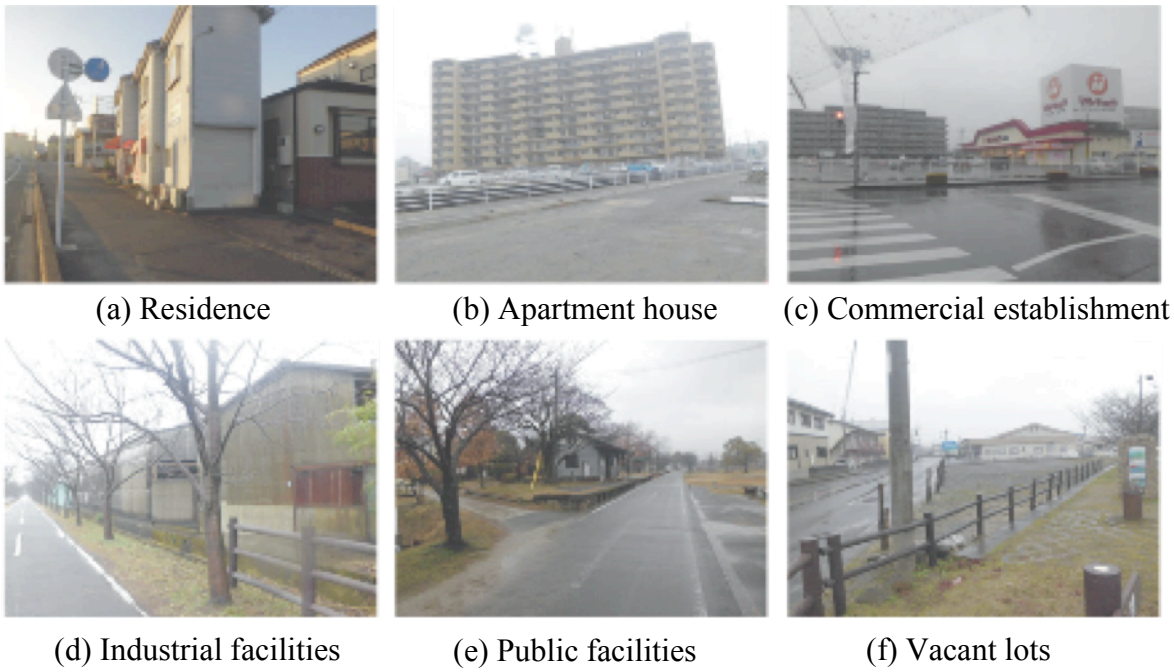
1.3 Purpose of Research

The purpose of the present research is to clarify the actual conditions and factors for use conversion, with focus on the land use conversions of the surrounding sites accompanying a change in an urban linear element.

2. RESEARCH METHODS

2.1 Research Site

The target linear element in this study is the Saga Line, which was built as a local line by the national railway in 1931 to connect Saga station of Saga City with Setaka station of Miyama City (when the railway was discontinued, the city was called Setaka Machi, Fukuoka Prefecture). The Saga Line was discontinued in 1987, and the site was converted mainly into a road, with a portion of a suburb of the city partially converted into a bicycle path in 1989.



(a) Residence (b) Apartment house (c) Commercial establishment

(d) Industrial facilities (e) Public facilities (f) Vacant lots

Figure 3: Current situation of surrounding sites.

2.2 Analysis of Time of Use

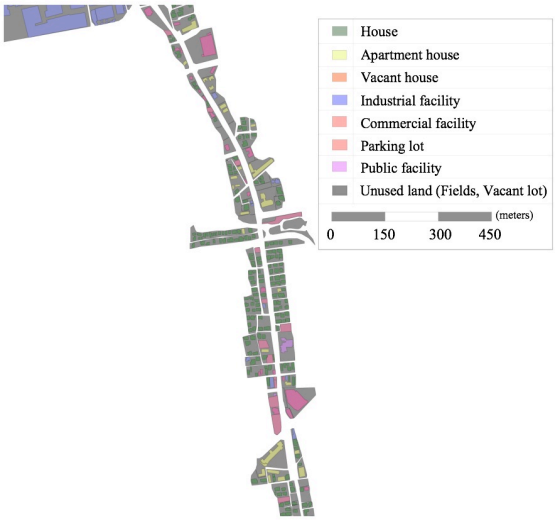
We performed an analysis by extracting the uses in 1984, 1987, and 2010 to clarify the changes to the surrounding sites that accompanied its use conversion or abolition. These years (1984, 1987, and 2010) correspond to three years before the railway was discontinued, the year when the railway was discontinued, and the current period, respectively. We checked and abstracted the land use of the surrounding sites using housing maps sold by Zenrin Corporation. Furthermore, we classified the land uses into residences, commercial establishments, industrial institutions, public facilities, and vacant lots. Here, the Japan building standard law requires the surrounding sites to face the discontinued Saga Line as a front street.

2.3 Change in Land Use of Surrounding Sites along Discontinued Railway

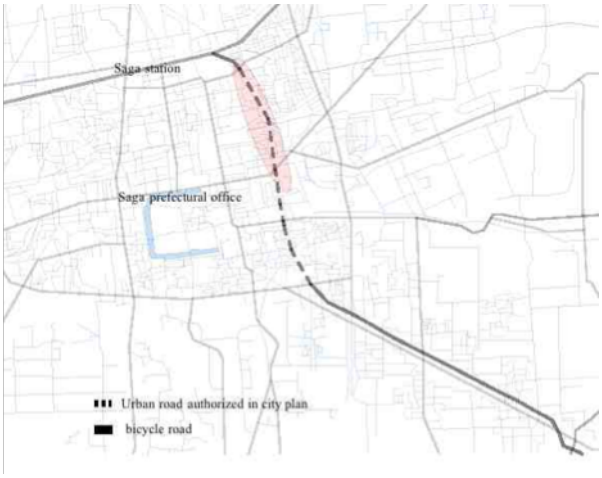
From the collected data, we could see that remarkable changes occurred from 1987 to 2010. These changes were caused by the use conversion of the sites surrounding the discontinued railway that accompanied the use conversion of the railway itself. Additionally, some sites showed no use conversions, probably because the introduction of the railway resulted in the formation of pieces of land that were inconvenient to use because of their shape.

(a) Land use of surrounding sites in 1984

(b) Land use of surrounding sites in 1987



(c) Land use of surrounding sites in 2010

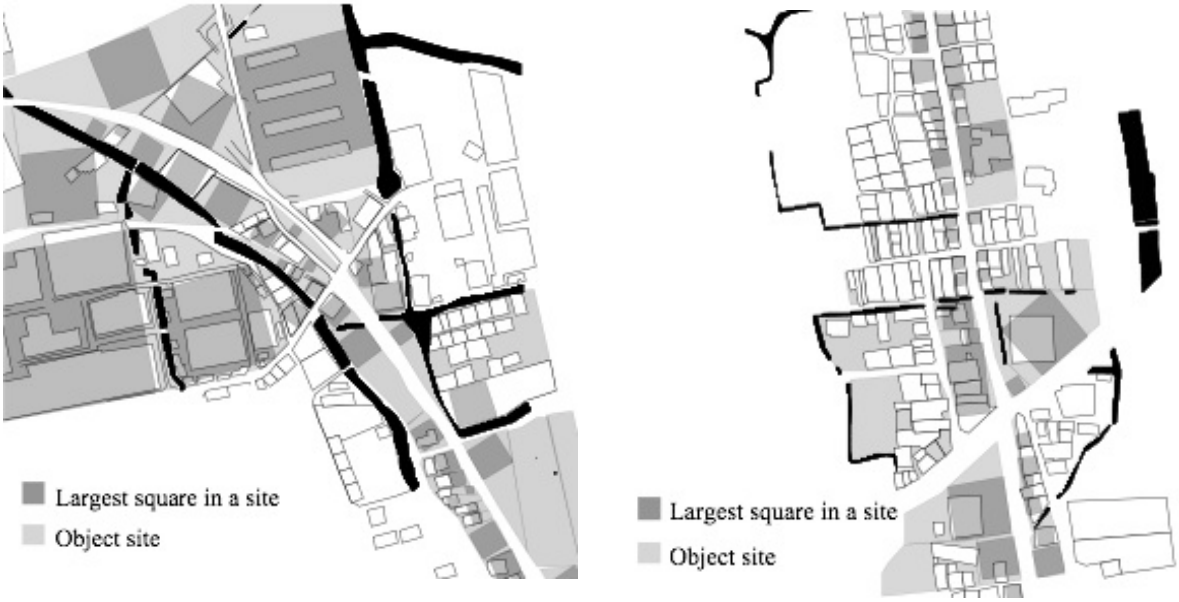


(d) Location

Figure 4: Change in land use of surrounding site along a discontinued railway site.

3. METHODOLOGY OF ANALYSIS

In this study, we analyzed the shapes and sizes of the surrounding sites to understand the land use tendency. To analyze the shape of the land, we defined a ratio of the shape to a square (hereafter, "RSS"), because we believe that a better organized shape can be used more effectively.



(a) Section where the line runs through the city block diagonally

(b) Section where the line runs in parallel with the city block

Figure 5: Example of forming a shape.

3.1 Definition of RSS

RSS is expressed as follows:

$$\text{RSS} = \frac{\text{Maximum square inscribed in site } (\text{m}^2)}{\text{Area of site } (\text{m}^2)} \times 100\ (\%) \qquad (1)$$

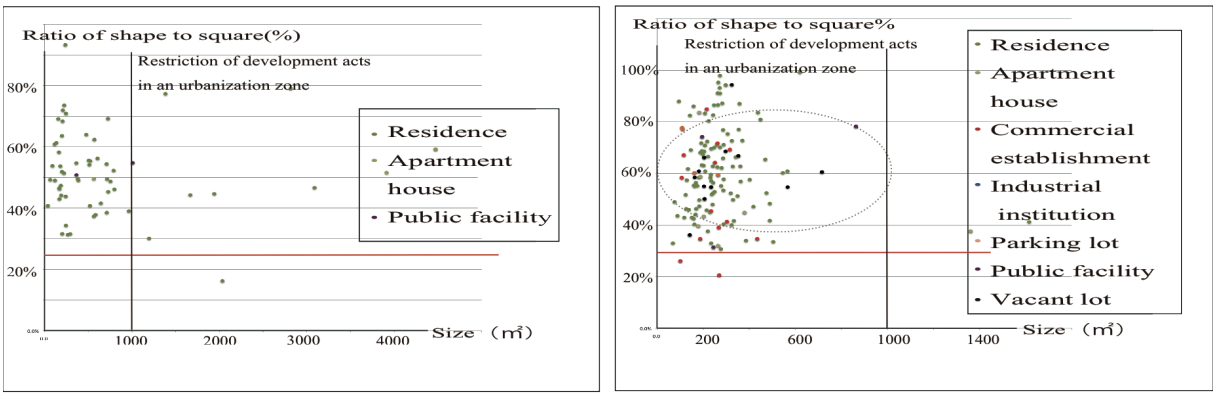
3.2 Examples of Forming a Square in a Site

First, the object sites must face the discontinued railway, as mentioned above. Next, one side of the largest square for the site is inscribed on the border line of the lot. To determine the real border of the site, we check the current situation of the site using the Zenrin housing map (see Figure 5).

4. ANALYSIS RESULTS

4.1 Relation between Site and RSS

Here, we show the results of analyses using RSS for the part where the line running diagonally through a city block is 50% or less and for the part where a line running in parallel through the city is 60% or more. RSS is lower if there are two or more axis lines for the city. A diagonal line also reduces RSS.



(a) Section where line runs through city block diagonally

(b) Section where line runs in parallel with city block

Figure 6: Conversion analysis inside an urbanization zone in 1984 (2010).

4. 2 Condition of Diversion Resulting from its Use

4.2.1 Inside an Urbanization Zone

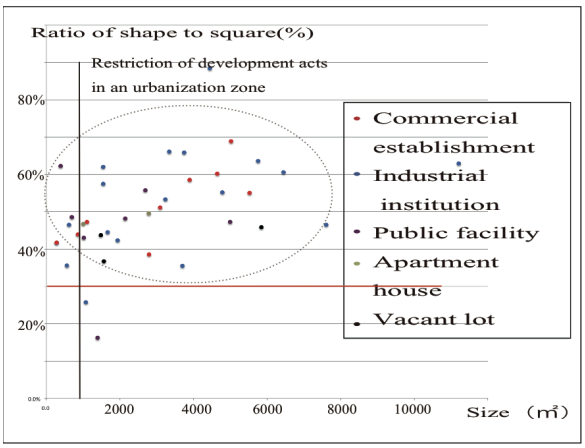
Most of the sites diverted to other purposes are located within the urbanization zone through city planning. Further, most of the sites that are used for housing are smaller than 1,000 m^2. Although the target area had many residences and apartment houses, the land was diverted to various uses. This was because areas that were smaller than 1,000 m^2 could be used for housing without development permission, according to the City Planning Act. Furthermore, there are many sites where RSS was greater than 30%. Sites of 1,000 m^2 or more were diverted mostly to land uses such as apartment houses (see Figure 6).

4.2.2 Conversion from Industrial Facilities

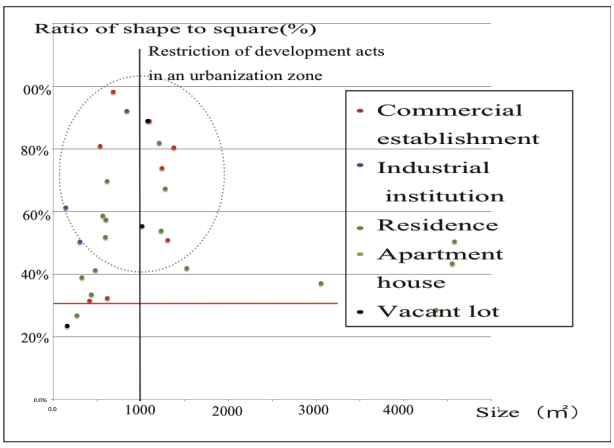
In the case of land used as industrial facilities in 1984, their RSS values were mostly greater than 30%, and there were very few sites where RSS was less than 30%. In terms of size, especially in the part where the linear element ran through blocks diagonally, many sites were larger than 1,000 m^2 (see Figure 7). This is because that part was located in the suburban area that originally contained many large sites. Sites larger than 1,000 m^2 were diverted mostly to uses such as apartment houses or commercial establishments.

4.2.3 Conversion from Vacant Lots

Many sites have RSS values of greater than 30% both in the section where line runs through citiy block diagonally and in the section where line runs in parallel with city block. The vacant lands were mostly diverted to various uses such as apartment houses and commercial establishments, but the sites where the RSS values are less than 30% are still

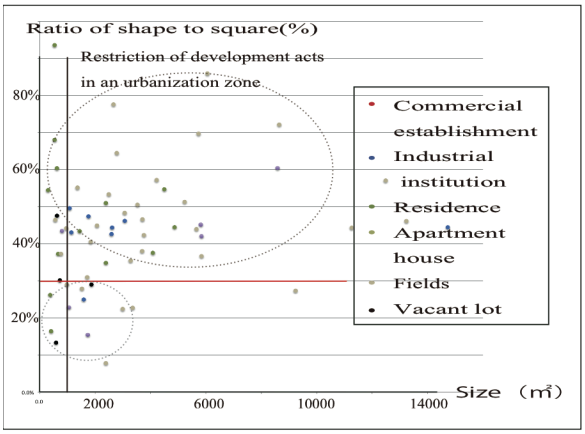


(a) Section where line runs through city block diagonally

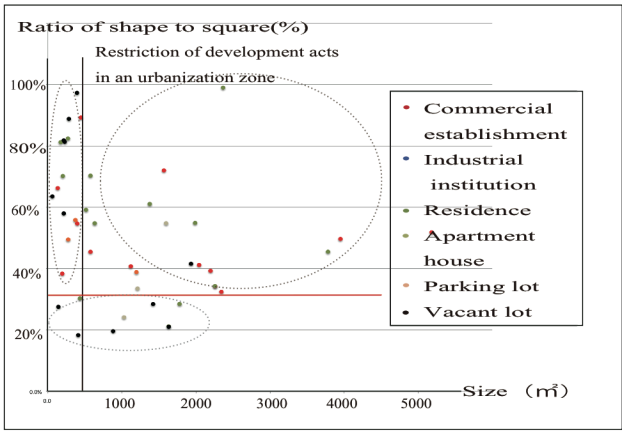


(b) Section where line runs in parallel with city block

Figure 7: Conversion analysis in the case of industrial facilities in 1984 (2010).



(a) Section where line runs through city block diagonally



(b) Section where line runs in parallel with city block

Figure 8: Conversion analysis in the case of vacant lots in 1984 (2010).

vacant lots. This is attributed to the present condition that the land is not used effectively. In addition, especially in the section where line runs in parallel with city block, many sites have sizes larger than 1,000 m^2 (see Figure 8). These sites were converted mostly into apartment houses and commercial establishments.

5. CONCLUSION

The abolishment of a linear element such as a railway influences the surrounding sites, or changes their use. At least in the case of the Saga Line, when the railway was discontinued

and the site was diverted into an urban road or a bicycle path through city planning, the surrounding sites were obviously diverted into other land uses.

The following points were then clarified in such a situation. 1) In particular, pieces of land smaller than 1,000 m^2 were diverted to other uses. This occurred because the development of a land smaller 1,000 m^2 did not require development permission under the City Planning Act. 2) The suburban area contains many vacant sites with sizes greater than 1,000 m^2. These sites have been diverted mostly to uses such as apartment houses and commercial establishments that require large areas. 3) Sites with RSS values smaller than 30% are still vacant lots. This fact indicates that sites with unusual shapes are difficult to use effectively. Therefore, we can say that the shapes of the sites created by the linear element influenced the later use of the land.

Considering the abovementioned points, we conclude that the land uses of the surrounding sites along a linear element such as the Saga Line are affected by the sizes and shapes that result from the linear element running through the city block and that we can clarify tendencies of land uses using the ratio of the shape to a square.

Finally, although we confirmed through an analysis of RSS that an abolished linear element influenced the land use of the surrounding sites, we could use the inverse approach of incorporating new linear elements into an existing city area in order to estimate how their incorporation would affect the future use of the surrounding land. We believe that it is useful to manage land uses of city blocks. But this method was not three-dimensional. Other than RSS, we could use the relationship between the shape of the block and shape of buildings. Furthermore, to apply the result of this study to other areas or countries, we could compare their differences and similarities, and know what each city planning system bring.

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