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Development of the Transport Network and the Urban System in Hokkaido, 1879–1975

Toru Taniuchi

Introduction

This paper aims to provide a basic and overall picture of the development of the transport network and the urban system in Hokkaido. The author is interested in studying transport as one of the useful approaches to the study of the development and change of urban system, taking account of the following considerations.

(1) An urban system could be regarded as a pattern consisting of urban centres of various size or status. A spatial aspect of the urban system could be identified through transport activities.

(2) The transport activities are essentially a spatial system in nature, connecting urban centres and other geographical localities. Transport is one of the most important aspects of urban function.

(3) Spatial units of the transport data, such as railway stations and ports, could be easily identified as geographical points. This is of great convenience operationally, compared with other various data of urban activities as population and retail sales which do not represent a point but a space with certain area, arbitrarily defined by administrative or other various criteria.

The study area of this paper is Hokkaido.¹⁾ As a field of the study, Hokkaido has the following characteristics.

(1) Hokkaido is one of the most easily and firmly identified regional units in terms of physical environment and historical background.

(2) Hokkaido is less densely populated than other parts of Japan. The longer distances among urban centres (at least from Japanese standard) suggest higher importance of transport network.

(3) The historical background of relatively shorter development experiences means weaker influences by Edo era. The more direct relationship between modern development of the transport network and the urban system is expected.

The period covered by the study is from 1879 to 1975,²⁾ the longest time span as far as reliable time-series data are available.

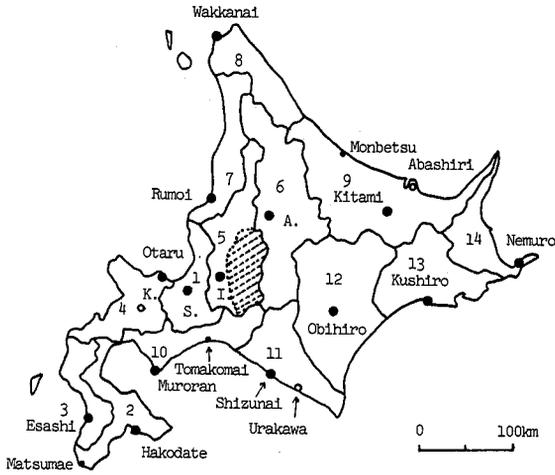


Fig.1. Location Map.

Notes: 1. Key to the regions.

1. Ishikari 2. Oshima 3. Hiyama
4. Shiribeshi 5. Sorachi
6. Kamikawa 7. Rumoi 8. Soya
9. Abashiri 10. Ihuri 11. Hidaka
12. Tokachi 13. Kushiro
14. Nemuro

2. The regional boundaries mainly follow the mountain ranges (water divides).

3. Location of Ishikari coal field should be noted for text and Figures 8 & 9.

4. Only present place names are referred in this paper.

- The largest urban centre in each region
- Location of Sub-Prefectural office (Except at the largest centre)
- Other centres

Ishikari coal field

S. Sapporo K. Kitchan I. Iwamizawa A. Asahikawa

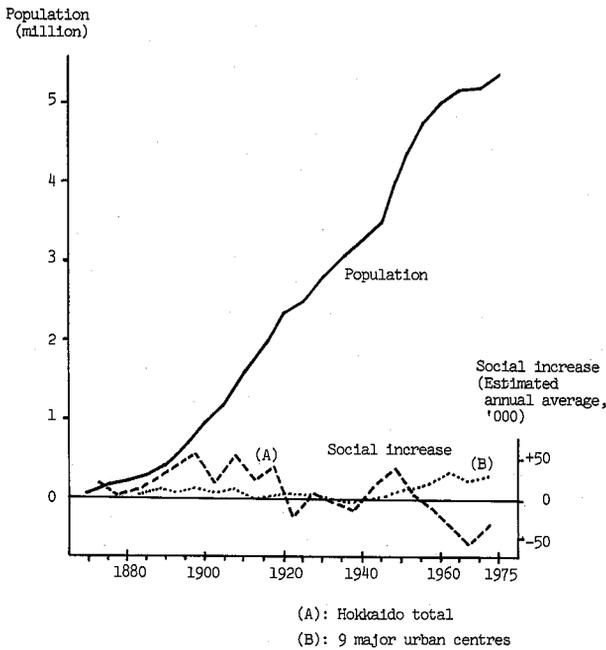
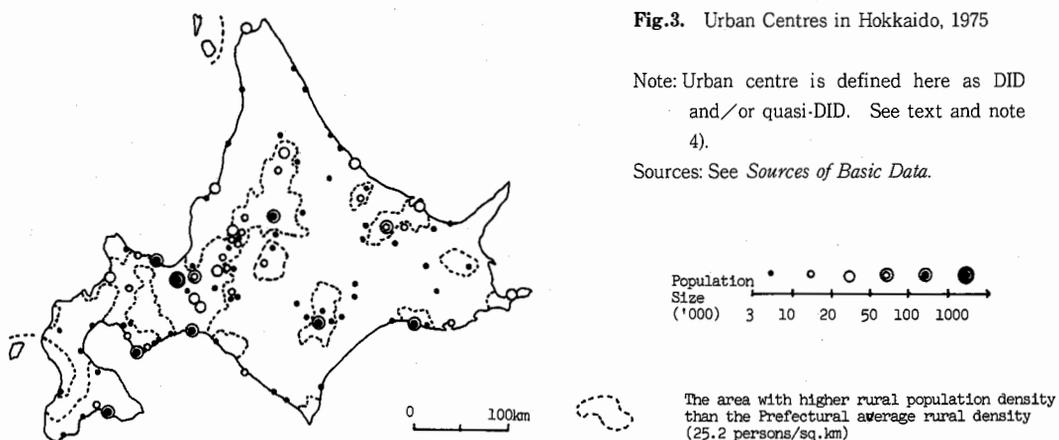


Fig.2. Population Growth in Hokkaido, 1869-1975

Note: For (B), see note in Fig.9.

Sources: See *Sources of Basic Data*.



The Population Growth and the Urban Centres

The population in Hokkaido grew very rapidly from 58 thousand in 1869 to 5.43 million in 1975. However, the long-term trend of social increase³⁾ is very contrasting. As Fig.2 shows, except a short period after the World War II, we can find three periods; the first period of increase (1880—1920), followed by the second period of stagnation (1921—1940) and the third period of post-war decrease. If we use a word "frontier" for a region of rapid social increase, Hokkaido's frontier stage might have ended in 1920. The year of 1920 could be called a turning point in this context.

The aggregate social increase of the 9 major urban centres shows a different picture. Before 1950, the changes were small. After 1950, these centres grew rapidly, moving to the opposite direction to Hokkaido as a whole. In fact, this relatively more rapid (or less declining) growth than Hokkaido as a whole began in 1920, the turning point year.

Fig.3 shows a present distribution of the urban centres. If we define urban centre as DID and quasi-DID,⁴⁾ the total urban population in Hokkaido shares 63.2% of the total population of Hokkaido, with the largest 9 centres absorbing 44.6% of the Hokkaido as a whole (1975). The distribution of most of the urban centres overlaps the area of relatively higher rural (non-DID) population density, especially the Asahikawa-Sapporo-Muroran corridor (mainly Sorachi and Ishikari regions). Another feature is that quite a few centres are found outside this corridor, mainly in the eastern and northern regions, implying the existence of relatively stronger local central functions.

Fig.4 shows a historical comparison of the urban centre location. As data directly comparable with 1975 DID population are not available, other similar data have been used. For a direct comparison among the different kinds and dates of data, each urban size has been expressed as a relative size to the largest centre. This relative status has been calcu-

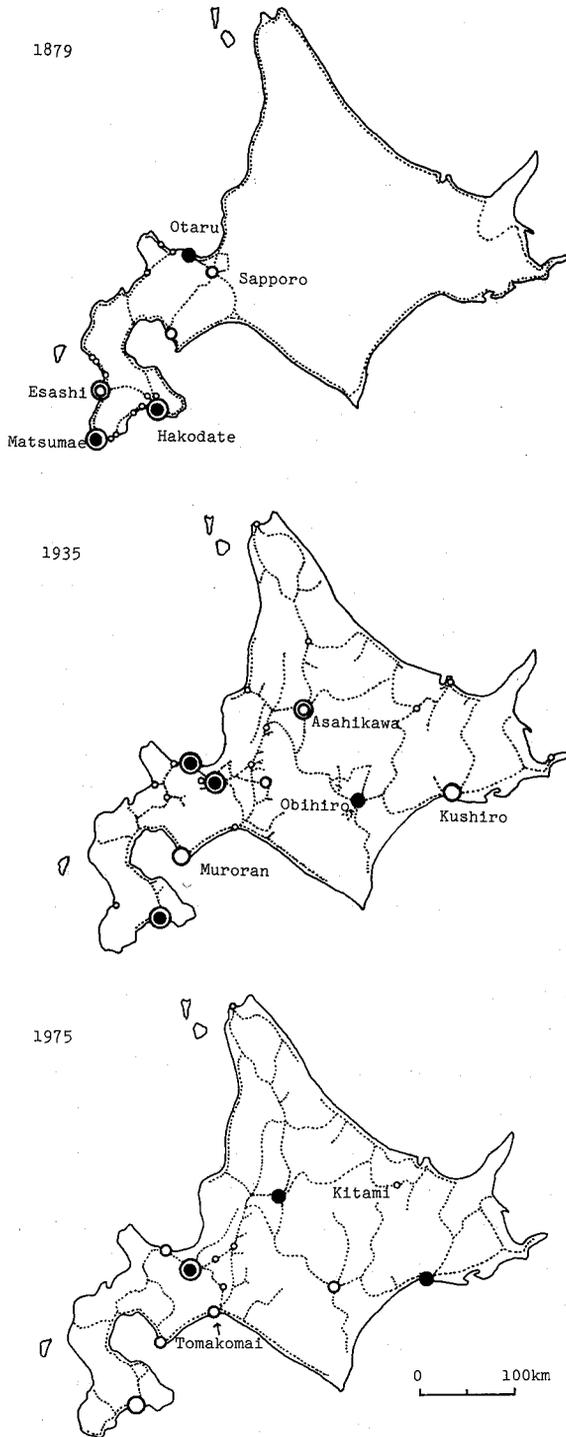
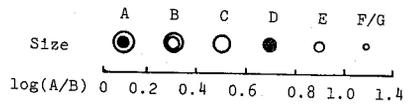


Fig.4. Changing Pattern of the Urban System and the Transport Network, 1879—1975

- Notes: 1. Data for urban size.
 1879: Population of the settlement(locality)
 1935: Number of households at the settlement (locality) of local government seat
 1975: DID population
 2. For $\log(A/B)$, see text.
 3. For road station(ekitei), see text and note 7).

Sources: Ministry of Finance(1885)
 Hokkaido Local Government Association .(1937)
 See Sources of Basic Data.

— { 1879 : Road network with road stations
 - - - - - { 1935 & 1975 : Railway network



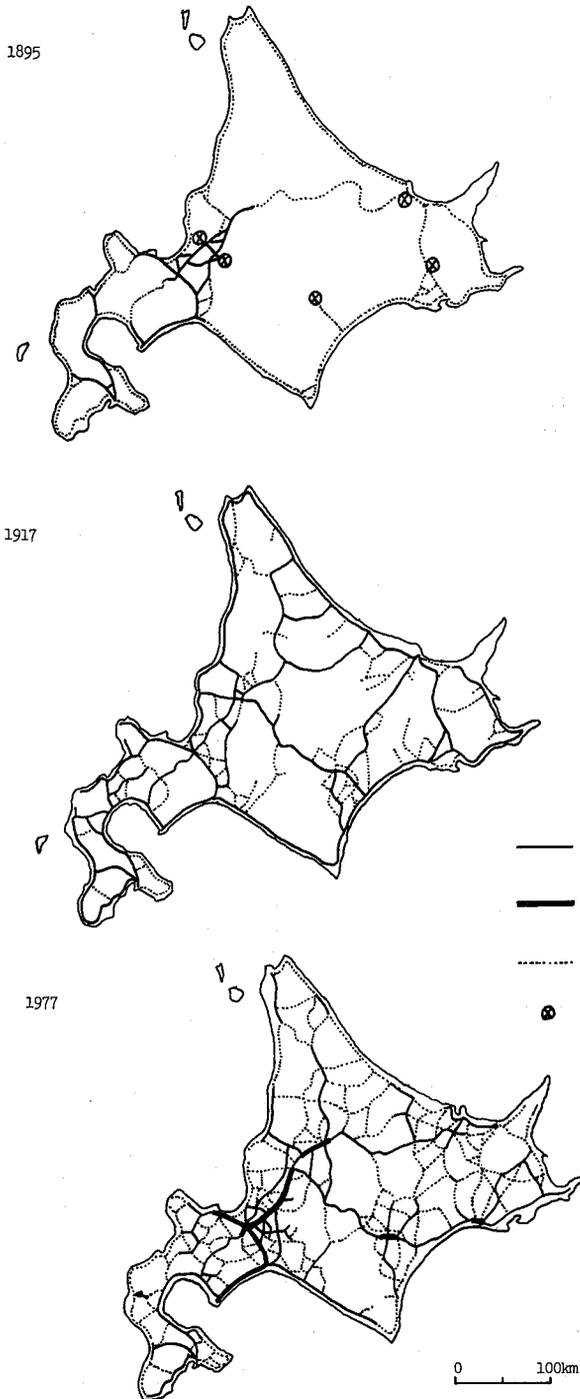


Fig.5. Development of the Road Network in Hokkaido, 1895-1977

Note: For 1879, see Fig.4.

Sources: Hokkaido Prefecture(1896)

Hokkaido Prefecture, *Road traffic map*, 1977 edition

Nakamura(1918)

Tazaki(1979)

- (1895: Vehicle roads
- { (1917: National & Prefectural roads
- { (1977: Roads with 2000 or more vehicle traffic (per daytime 12 hours)
- (1977) With 10000 or more
- { (1895 & 1917: Other roads with road station services
- { (1977: Other national highways & Prefectural main roads
- ⊙ (1895) prisons

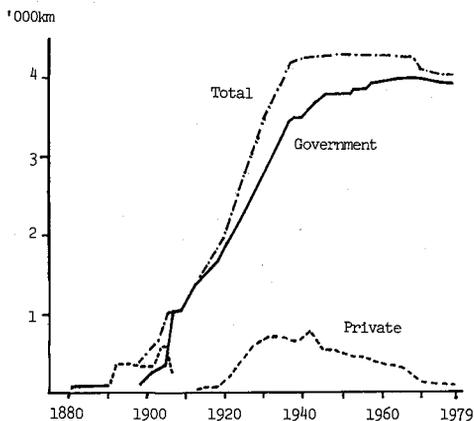


Fig.6. Railway Mileage in Hokkaido, 1880-1979

Sources: See *Sources of Basic Data*.

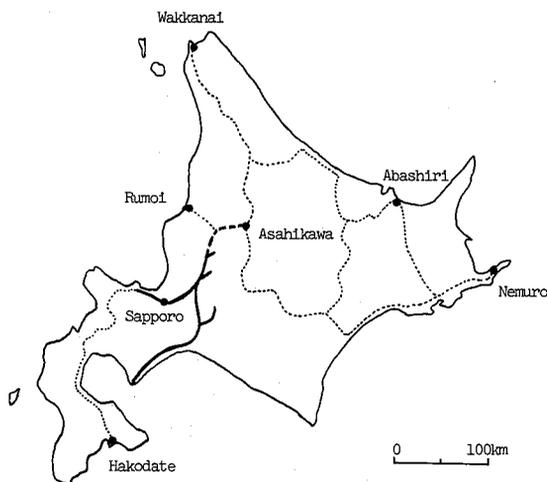


Fig.7. The Network Planned by the Hokkaido Railways Construction Act(1896)

Source: Japan National Railways(1976)

lated as $\log(A/B)$, where A is the size of the largest centre, and B is the size of each centre. For instance, $\log(A/B)$ of 1.0 means that the size of the centre concerned is one tenth of the largest. If this figure decreases, the relative status goes up, i. e. grows more rapidly than the largest, and vice versa. If many centres go up, it means a trend of decentralisation, and if go down, a trend of centralisation.

The major findings from Fig.4 are as follows.

(1) A spatial pattern of the urban centre distribution has changed considerably, especially from 1879 to 1935. The leading urban centres in 1879 were those with longer history since the Edo era (Matsumae, Hakodate and Esashi).⁵⁾

(2) If we divide the centres shown in Fig.4 into major centres (A-E) and minor ones

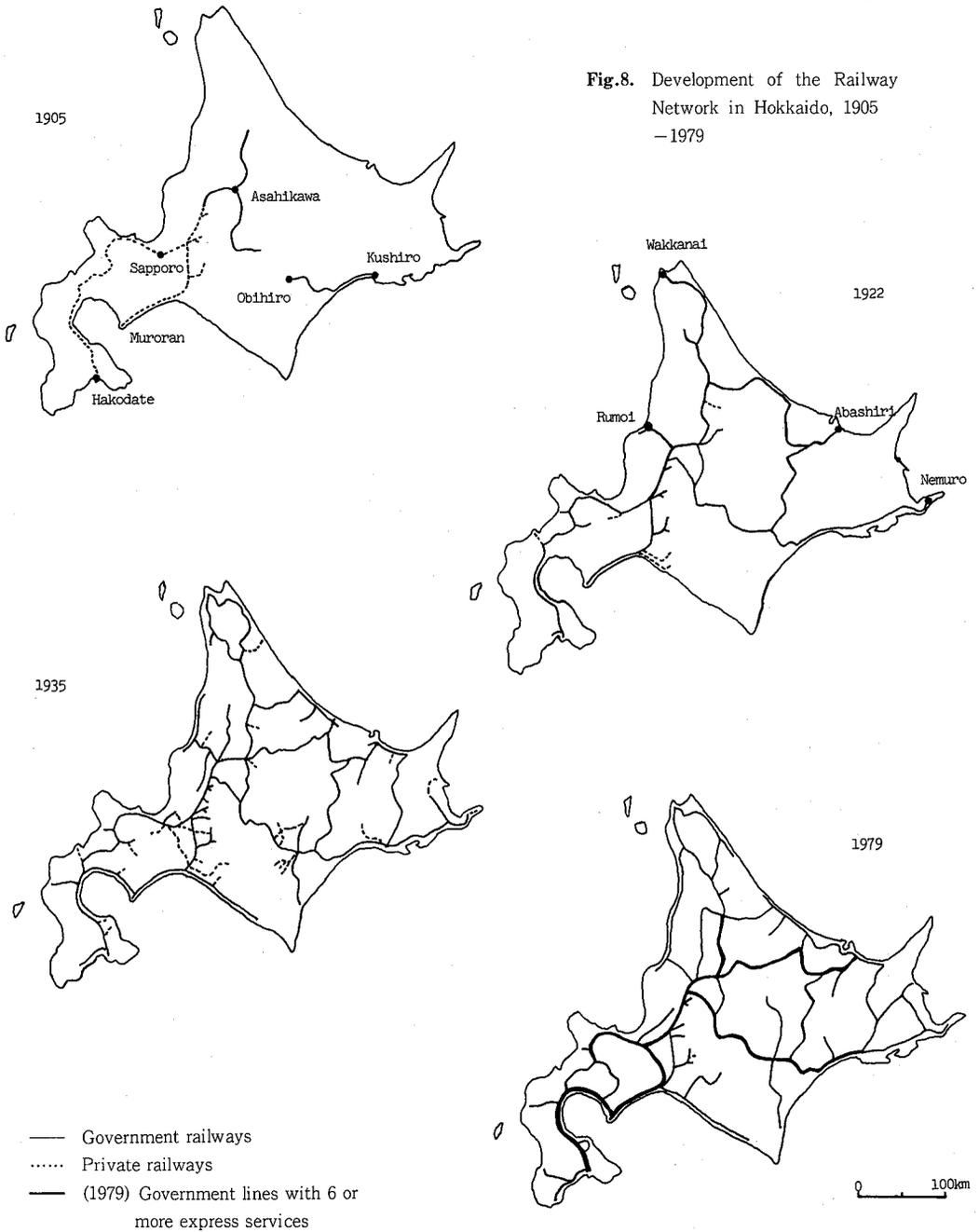


Fig.8. Development of the Railway Network in Hokkaido, 1905 - 1979

Note: For other dates, see Fig.9.
Sources: See *Sources of Basic Data*

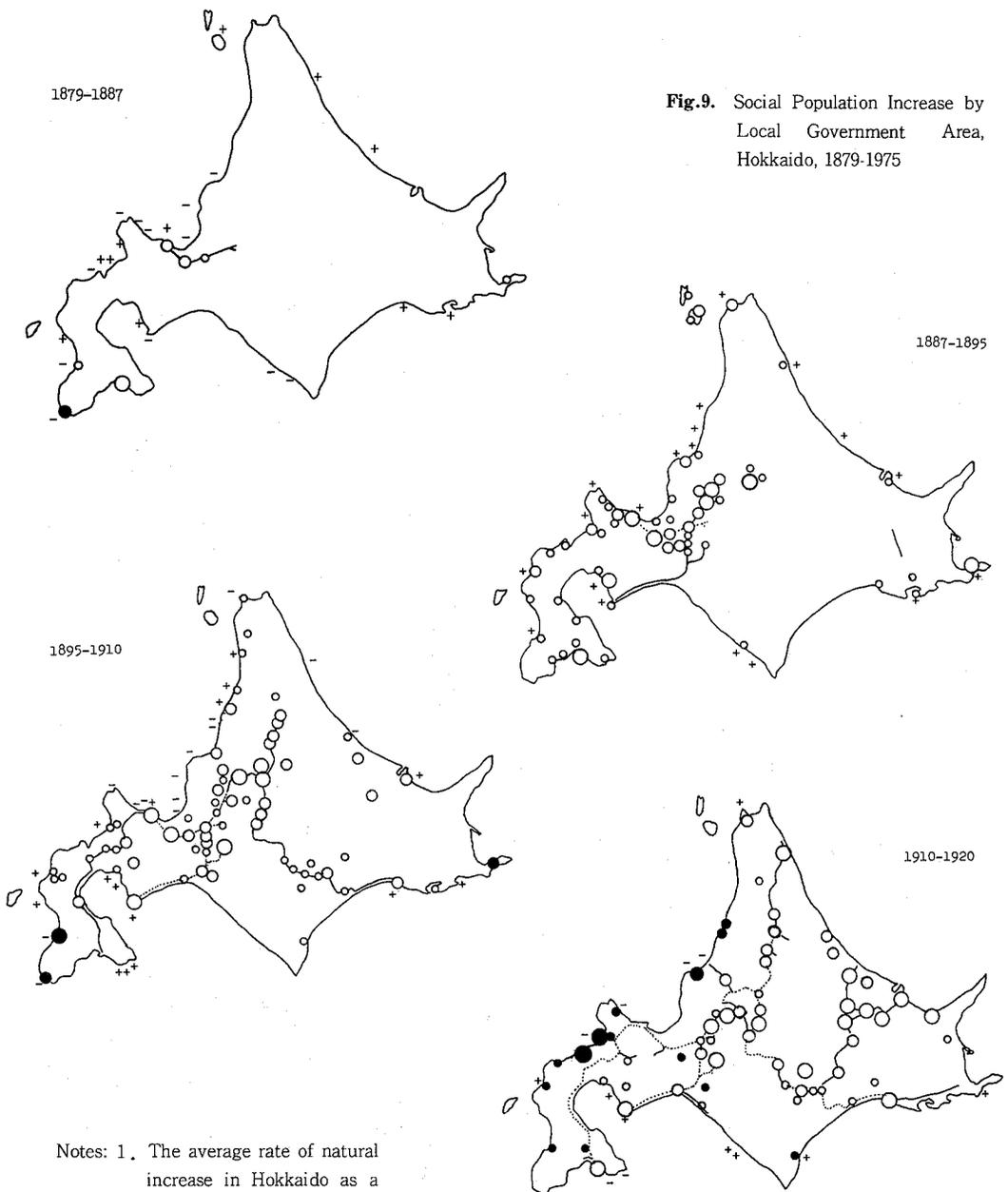
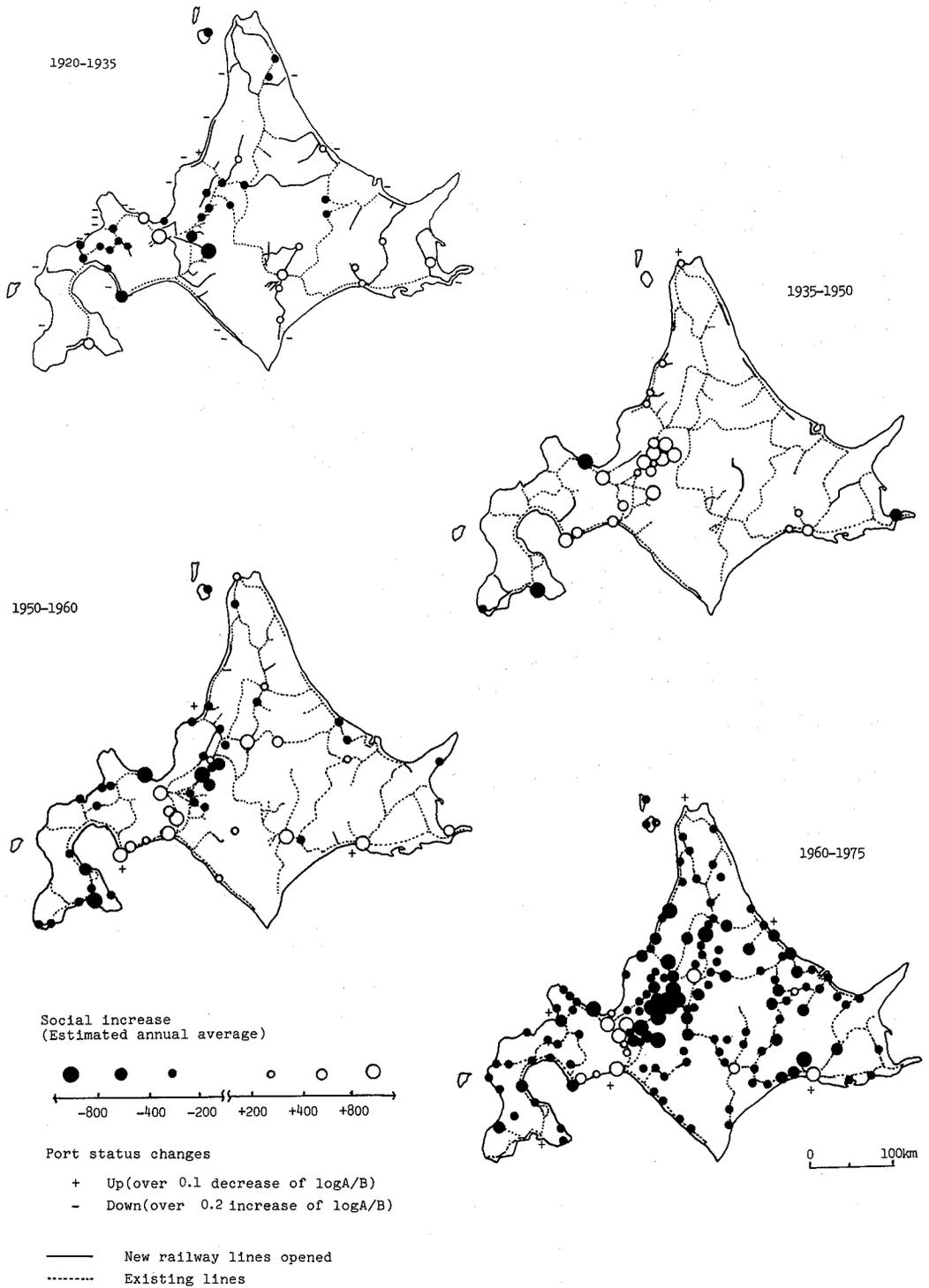


Fig.9. Social Population Increase by Local Government Area, Hokkaido, 1879-1975

- Notes: 1. The average rate of natural increase in Hokkaido as a whole in each period has been used, with 0.5% allowance, i. e. the higher rate (average +0.5%) for increase and the lower rate (average -0.5%) for decrease.
2. For $\log(A/B)$, see text.

3. Population data have been adjusted to the 1975 local government boundaries.

Sources: See *Sources of Basic Data*.



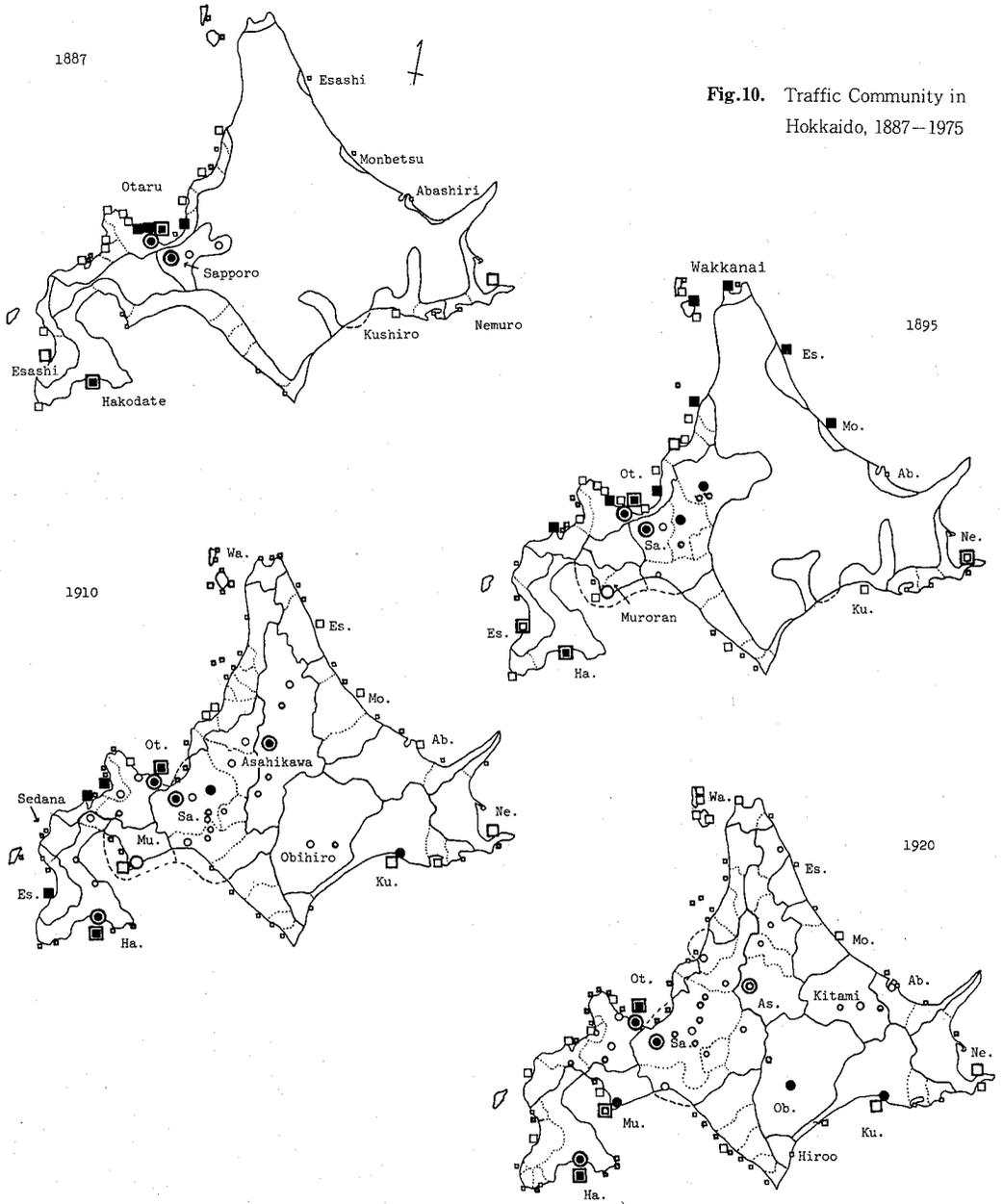
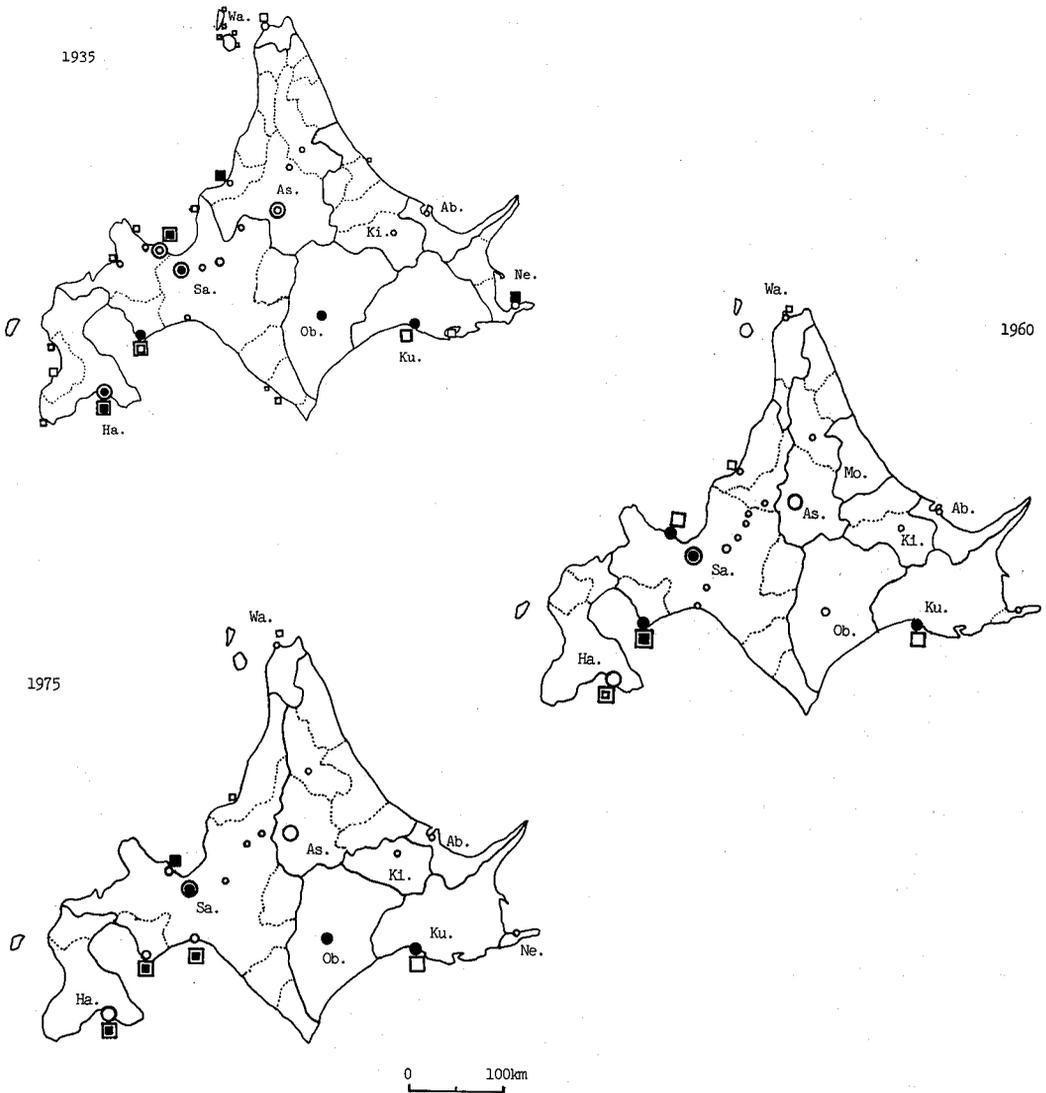


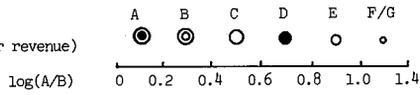
Fig.10. Traffic Community in Hokkaido, 1887—1975

- Notes: 1. For traffic community, see text and notes 8)—10).
 2. For $\log(A/B)$, see text.
 3. Primary boundaries omitted.

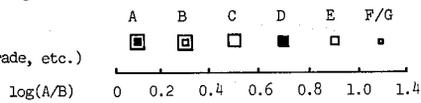
Sources: See *Sources of Basic Data*.



Railway
(Railway passenger revenue)



Port
(Total value of trade, etc.)



Traffic community boundaries

—— Tertiary
 Secondary

(F/G), the number of centres in each group increased only slightly between 1879 and 1935, in spite of the fundamental change in spatial pattern. In the period between 1935 and 1975, the number of the major centres did not change, while the number of the minor centres decreased. Location pattern of the major centres did not change, except Tomakomai.

(3) From 1879 to 1935, many centres "went up", i. e. decentralisation occurred. From 1935 to 1975, however, many of the major centres (except Tomakomai) went down, i.e. centralised.

(4) Most of the centres are on the transport networks. From 1879 to 1935, the major change in transport network (i. e. building up the network) coincided with the change in urban system. From 1935 to 1975, transport network changed only slightly, while urban patterns changed much more. It seems to suggest that the development of the transport network had a strong relationship with the urban system, and that once the network was established, rather a trend of centralisation has become stronger.

The Development of the Transport Network

The development of the transport network to the interior of Hokkaido began by road construction.⁶⁾ By 1895, a penetration line to the eastern part had been constructed by convicts labour. (See location of the prisons in Fig.5.) By 1917, most roads of the present network were already open and road station (ekitei) services were available.⁷⁾ Although the road network has developed much more since these days, the present network, especially the routes with heavier traffic, shows a similar pattern as the early days (Fig.5). Although the road extensions preceded the railways, the influence or contribution by the road network were limited in later days, giving way to the railway development.

The railways constructed in the earliest days were to transport coal from Ishikari coal field to the ports of Otaru and Muroran. At the end of the 19th century, and especially after the nationalisation of the railway system in 1906, the railway network began to develop rapidly, reaching the peak in late 1930's (Fig.6). The basic trunk line network planned by the Hokkaido Railway Construction Act of 1896 (Fig.7) had been almost completed in 1922 (Fig.8). Railway developments after that date were mainly branch lines and bridge lines. The present railway network, especially that of busy lines, shows a similar pattern as the road network as well as the earlier railway networks.

The Railway Development and the Population Changes

Through the brief discussion on the general background of population and transport network scene in Hokkaido, we could expect that a certain strong relationship between the population/urban growth and the development of transport network could be established. Using the time-series data of population, railways and ports (see the related information on the

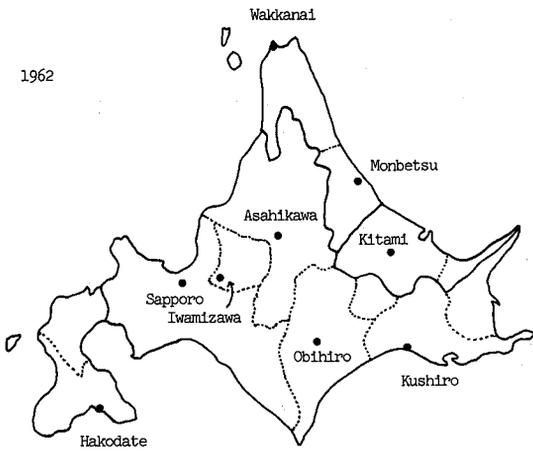
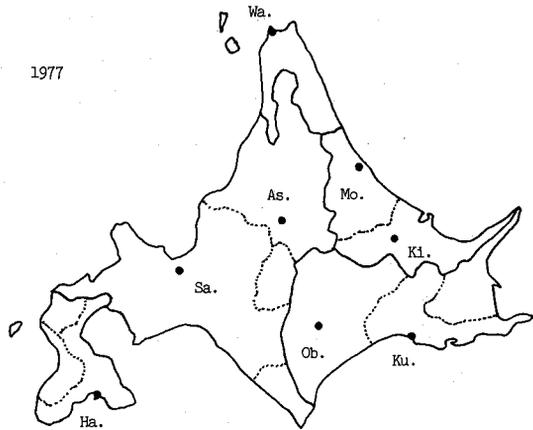
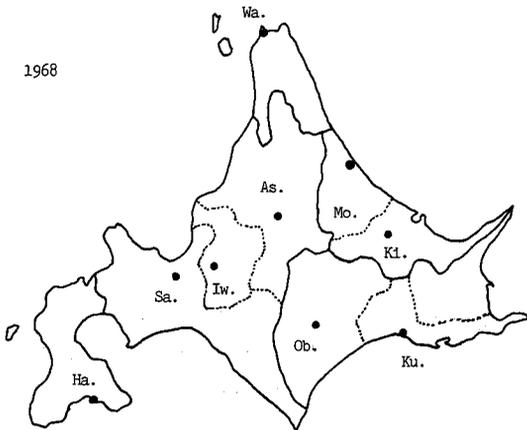


Fig.11. Road Traffic Community in Hokkaido, 1962-1977

Sources: 1962: After Arisue(1964)
1968 & 1977: Hokkaido Prefecture,
Road traffic map.



Traffic community boundaries
—— Tertiary
- - - - Secondary

0 100km

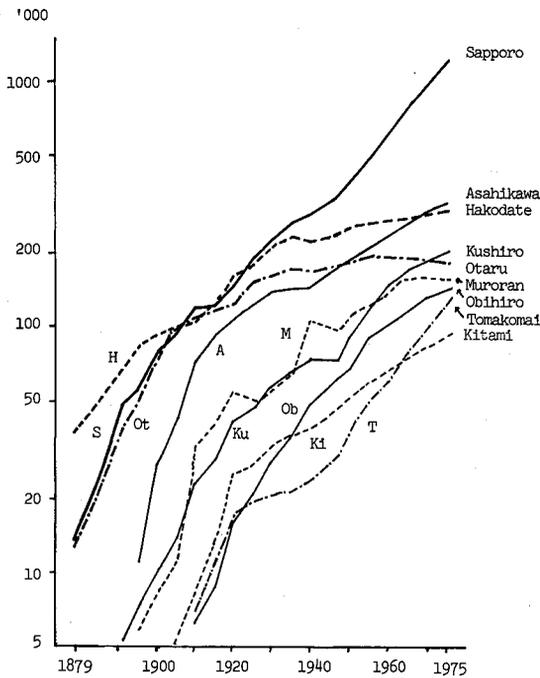


Fig.12. Population Growth in the Major Urban Centres, Hokkaido, 1879–1975

Notes: 1. The nine largest urban centres in 1975 are selected.

2. Population data have been adjusted to the 1975 local government boundaries.

Sources: See *Sources of Basic Data*.

sources at the end of the paper), we could try some simple analyses below.

Fig.9 shows the social population increase (population inflow) by local government area, changing port status and the railway extensions. The major findings from Fig.9 are as follows.

(1) In the periods between 1887 and 1920 of railway penetration stage through Asahikawa to the interior, population along the newly opened lines increased rapidly by population inflow, beginning in Sorachi region, followed by Kamikawa, Tokachi and Abashiri regions.

(2) Port status declined in many cases, especially in the western coast from Shiribeshi to Rumoi regions in the period between 1895 and 1920, followed by Soya, Abashiri and Hidaka regions in 1920–1935. This means the change or transformation from the port-based transport network into the railway-based network.

(3) In the periods after 1920, except the fluctuating coal field area, social increase occurred in urban centres with parallel spread of depopulating areas.

(4) Among the major urban centres, the long established port cities have begun to decline, with the contrast to the rapidly growing interior centres.

(5) The year 1920 could also be regarded as a turning point of these changes as well as the end (completion) of the construction of railway trunkline network.

The Changing Traffic Community

Fig.10 is the result of the work based upon the idea of "traffic community" after Arisue (1957, 1964 & 1968), a sort of nodal region concept.⁸⁾ The author has already applied this method to Hokkaido in the pre-war scene (Taniuchi, 1979ab). The author tries again to apply the same method here, to the extended period up to 1975, with a small modification giving more attention to traffic flows than to revenues.⁹⁾ As in the earlier studies by the author, port activities have been complementarily taken into account in the areas not accessible to the railway network.¹⁰⁾

Major results of this work are as follows.

(1) The number of the tertiary centres (and also tertiary traffic communities) were the largest in 1910 and 1920. This suggests the change from the decentralising trend to the centralising trend in this period.

(2) After 1935, changes in the number and location of the tertiary centres were relatively small, although the boundaries of the tertiary traffic communities have changed in the direction of centralisation.

(3) The survived tertiary centres in 1975 have been enjoying the same status at least since 1920 (except Nemuro in 1960). This suggests that, once the transport network had been established, it was difficult for other centres of lower status to climb up to the higher status.

In view of the rapid development of road transport in the recent days and the decline of relative importance of railways, attention should be given to the road transport. As in the railway case, the similar idea of road traffic community has already been introduced by Arisue (1964 & 1968). The method is the simple repetition of finding peaks and bottoms on the traffic flows, because counterpart information to passenger revenue is not available. Fig.11. shows the results of this work for the recent years. Although some differences from the railway case could be easily found, at least partly reflecting the technical difference in the method, overall picture is not far from the railway case. If we pay more attention to the secondary traffic communities, overall stability could be identified. It might suggest relatively more local nature of road transport than railways.¹¹⁾

The Relationships among the Different Kinds of Status Data

The analysis of railway activities in the last section established the overall picture of urban systems through railway passenger revenues, assuming that the railway activity could represent the urban status. The purpose here is to discuss the relationships among the different kinds of data, i. e. population, railway and port activities, focussing on the experiences in the 9 major urban centres. As the preceding analysis, status figures of $\log(A/B)$ are used.

Fig.12. shows the population growth in the major centres with semi-logarithmic scale.

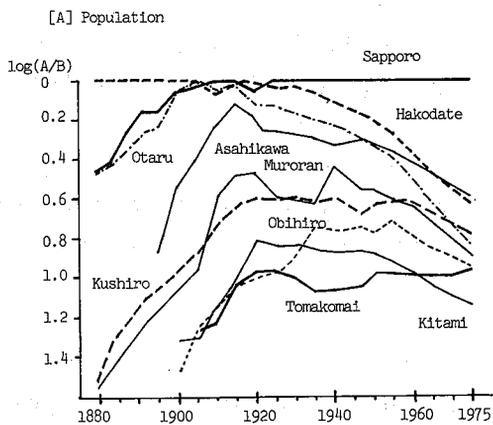
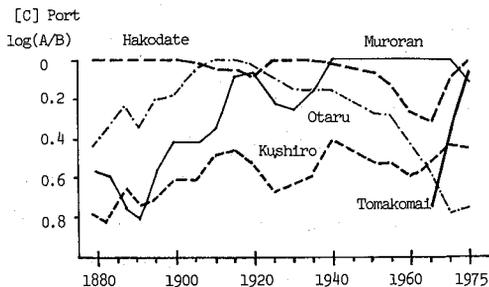
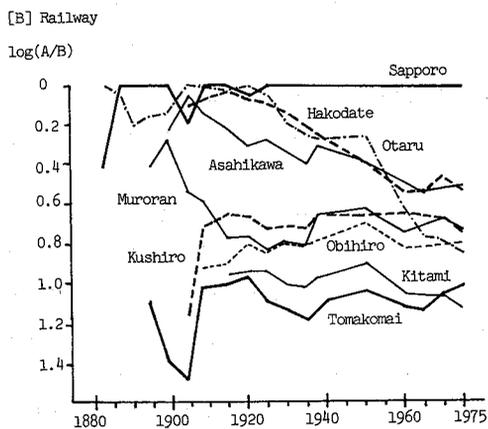


Fig.13. Changing Status of the Major Centres in Hokkaido, 1879-1975

Note: For $\log(A/B)$, see text.

Sources: See *Sources of Basic Data*.



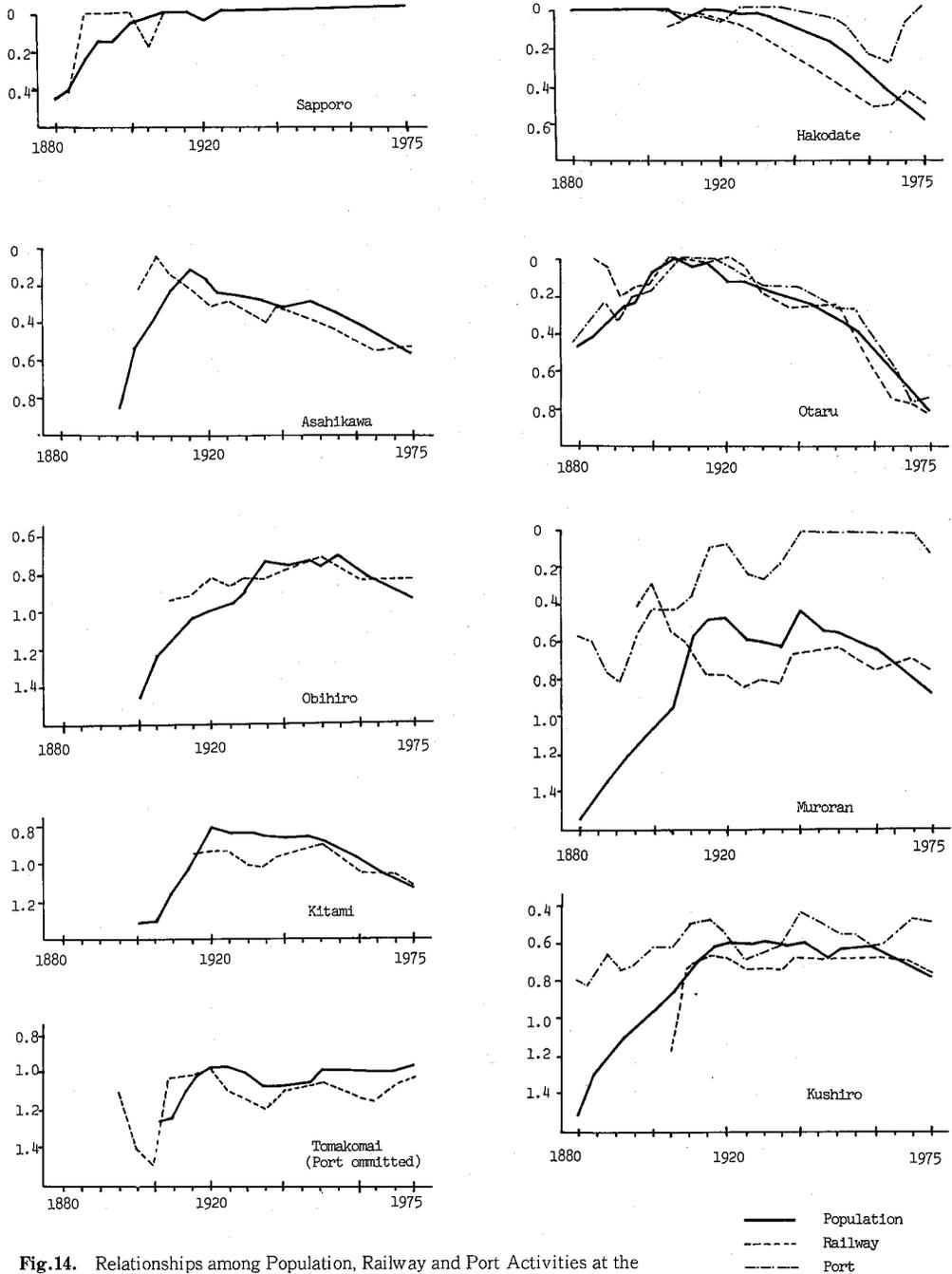


Fig.14. Relationships among Population, Railway and Port Activities at the Major Centres, Hokkaido, 1879--1975

Note: For $\log(A/B)$, see text.

Sources: See *Sources of Basic Data*.

This simple graph could tell us some points such as the long-term rapid growth of Sapporo, followed by Asahikawa, Kushiro, etc., and the relative declines of Hakodate and Otaru. These relative changes could be more sharply expressed by Fig.13[A], which shows clearly the importance of the year of 1920 as the turning point from upward trend to downward (or at least horizontal) trend, and an overall parallel movement pattern, implying a general stability of the urban system as a whole. The same kind of graph for railway also shows the similar trends (Fig.13 [B]), although the port graph (Fig.13 [C]) shows some differences, at least partly because the data represent cargo movement, which is more affected by other factors than urban system itself. Fig.14. shows the relationship for each centre. Overall parallel movement could be found in most cases, which confirms the general relationships among the different kinds of status data.

Conclusion

By the analyses based upon the relative status data of population, railway and port activities, the following remarks could be confirmed.

(1) Transport network as well as transport activity has strong relationships with urban population trends and patterns, reflecting the nature of urban system in common.

(2) In the case of the development experience in Hokkaido, the importance of the year 1920 as the turning point has been identified. This suggests that, during the period of the formation of a transport network, rather decentralising trend is general, while overall stability and centralising trend (reinforcement of the existing pattern) appear later.

Notes

- 1) Hokkaido is one of the 47 Prefectures and also one of the 7 wider conventional regional divisions. The area is 78117 sq.km, the population is 5.34 million, with the population density of 68 persons/sq.km (1975).
- 2) The author has recently published three papers of similar interest to this paper (Taniuchi, 1979a, 1979b & 1979c), for the pre-war period. This paper is a revised and extended work based upon the data and the results of the preceding studies.
- 3) Annual average number of social increase for each period has been calculated from the data on total population change and natural increase at each period. Although migration data have been published, they are not used in this study, because they fail to be consistent with the total population change and natural increase.
- 4) DID(Densely Inhabited District) is defined by the Bureau of Statistics since 1960. DID is a set of contiguous census tracts with 4000 persons/sq.km or over, having aggregate population size of 5000 or more. Quasi-DID is the same kind of district with population size of 3000 or more.
- 5) Matsumae had long been the capital (castle town) of feudal rule in Edo era. Hakodate took over this status in the earliest days of Meiji era before Sapporo was established as a capital. Hakodate also enjoyed leading economic status as one of the first open ports to foreign ships. Esashi is an example of a boom town by herring fishing since Edo era.

- 6) Although shipping links and coastal walking tracks had long been available, they were not sufficiently reliable. With the intention to open inland and to make shorter main routes to the eastern coast, road construction to the east through the interior was thought to be of primary importance.
- 7) Road stations (ekitei) provided travellers with accommodation and other essential services, getting subsidy and supervision by the Prefectural government (or equivalent administration before prefecturalship). This system began in Edo era and was finally abolished in 1947. The road station system is a good guide to identify the road network in the early days.
- 8) The method by Arisue to set up a system of traffic communities is as follows.
 - (1) Find out peaks and bottoms along the railway passenger flow. A space surrounding the peak and limited by the bottoms is identified as a primary traffic community, the peak station as a primary centre.
 - (2) Compare the railway passenger revenues of the two primary centres A and B (assume here A to be larger than B) by calculating θ as defined below,
$$\tan\theta = \frac{\log(A/B) \times 100}{D}$$
where A and B are passenger revenues (yen) and D is the railway distance between the two stations (km).
 - (3) If $\theta > 50^\circ$, B belongs to A, and if $\theta \leq 50^\circ$, B is independent from A. Finally the stations which do not belong to any other stations are identified as secondary centres.
 - (4) The same procedure is repeated among the secondary centres and identify tertiary centres, but adopting 25° instead of 50° .
- 9) The author's modified method is as follows.
 - (1) Identify primary centres (same as the original method).
 - (2) First of all, identify tertiary centres by beginning the comparison between the two largest stations. After all the tertiary centres are identified, decide boundaries between the pairs of the neighbouring tertiary centres, by finding the smallest traffic point in between.
 - (3) The same procedure applies to identify secondary centres.
- 10) As traffic flow data are not available, $\theta = 60^\circ$ was arbitrarily used to identify primary centres, then followed the original method.
- 11) By applying the same method to the railway case, the author obtained the result that most part of Hokkaido was included into the largest tertiary community centred on Sapporo. It could suggest the long distance nature relative to road traffic and railway traffic in the past.

Sources of Basic Data

(For full titles, see references)

(A) Population

1. Population of Hokkaido as a whole, 1869--1975
Hokkaido Prefecture: *Statistical yearbook* and Uehara(1941)
2. Population by local government area, etc.
1879: Army(1880) and Kaitakushi(1880)
1883: Hokkaido Prefecture(1886), Nemuro Prefecture(1885) and Sapporo Prefecture(1885)
1887--1920: Hokkaido Prefecture: *Population statistics*
1920--1975: Bureau of Statistics: *Population census of Japan* and Hokkaido Prefecture: *Statistical yearbook*

- Notes: 1. For 1879, partly substituted by 1878 data in Army(1880).
2. For 1887, partly substituted by 1888 data.
3. Selected dates for five year interval are 1879, 1883, 1887, 1891 and every 5 years from 1895 to 1975, except 1947 for 1945.

(B) Railway

1. Basic chronological facts of railway construction, mileage, etc.
Hokkaido Prefecture: *Handbook for current situation*, Izawa(1937), Japan National Railways(1976), Ministry of Transport: *Statistical compendium of transport in Hokkaido*, and Umeki(1959)
2. Railway passenger flow and revenue by station
1879: Ministry of Finance(1885)
1887--1895: Hokkaido Prefecture(1896)
1900--1905: Hokkaido Prefecture: *Statistical yearbook*
1909--1938: Ministry of Railways: *Statistical yearbook*
1950--1975: Japan National Railways: *Statistical yearbook* and Japan National Railways: *Compendium of railway statistics*

- Notes: 1. For 1910, passenger revenue data were substituted by 1909 data.
2. Data for private railways after 1910 were not available except passenger traffic data for 1930 and 1935 from Hokkaido Prefecture: *Statistical yearbook*.
3. Data from Japan National Railways: *Statistical yearbook* were partly quoted through Hokkaido editions published by Hokkaido Branch Office.
4. Selected dates for five year interval are 1887, 1891, every 5 years from 1895 to 1935, 1938, every 5 years from 1960 to 1975.
5. Status data for 1879 and private railways in 1935 are the author's estimates from passenger traffic data.

[C] Port

1. Number of ships entered by size group
1879: Ministry of Finance(1885)
2. Tonnage of ships entered
1883: Hokkaido Prefecture(1886 & 1896), Nemurò Prefecture(1885) & Sapporo Prefecture(1885)
1887—1895: Hokkaido Prefecture(1896)
1900—1905: Hokkaido Prefecture: *Statistical yearbook*
1906—1925: Ministry of Interior: *Statistical yearbook of ports and harbours*
3. Value of cargo handled (excluding intra-prefectural movement)
1895: Hokkaido Prefecture(1896)
1900—1915: Hokkaido Prefecture: *Statistical yearbook*
4. Value of cargo handled
1906—1935: Ministry of Interior: *Statistical yearbook of ports and harbours*
5. Tonnage of cargo handled
1920—1975: Ministry of Transport: *Statistical yearbook of ports and harbours*

Notes: 1. For 1906, partly substituted by 1905 data.

2. Data from Ministry of Interior and Ministry of Transport: *Statistical yearbook...* were partly quoted through other publications.

3. Selected dates for five year interval are 1879, 1883, 1887, 1891, 1895, 1900, 1906 and every 5 years from 1910 to 1940, 1951 and every 5 years from 1955 to 1975.

4. Status data have been estimated by consolidating the data above with higher priority to the value of cargo handled.

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- Notes : 1. All in Japanese, except post-war bilingual publications by Bureau of Statistics.
 2. Titles are not necessarily official or direct translations.
 3. Some government publications of the same kind with different names of authorities and/or titles are represented by only one or two of them (e. g. statistical series of railways and ports).