A Study on the Land Use Change in Kurosaki and A Proposal of an Urban Biotope Network

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Abstract
In the pre-Industrial Period the Kitakyushu City had a rich natural environment. Due to industrial developments, the expansion of the residential and industrial area has caused severe destruction of this natural environment. Several natural areas are still left in the urban area. Above of that in the last 25 years the population has decreased and the city area has sprawled further. In this research, the change of land use in the Kurosaki Sub center in the Kitakyushu Industrial Belt in Japan has been investigated. Furthermore, a proposal has been made for the development of an urban biotope network in the Kurosaki Sub center.

Keywords: change of land use; restoration of nature; biotope network

1. Introduction and Purpose of This Research
Over the last 25 years, the city of Kitakyushu has been suffered several urban problems, which were mainly a result of the change in the industrial sector. The industrial city of Kitakyushu is located along the Sea of Genkai in the north, and is surrounded by mountains in the south. In the pre-industrial period, an abundant natural environment has characterized this city. Since the Industrial Revolution, this almost inhabited agrarian landscape has been changed into a typical densely build urban industrial landscape.

Industrial developments in Kitakyushu City required factories, energy plants and other industrial buildings, as well as infrastructure, such as railways, canals, roads, harbors, etc. Large natural areas in the city have been reduced or even completely been destroyed due to these expansions of infrastructure, industrial and residential area. The city of Kitakyushu has a population of about 1 million people and covers a land area of about 480km². One big problem is the decrease of its population since the 1980’s. Figure 1 shows the change of population for the period 1970. The population increased from 1,042,321 in 1970 until 1,068,415 in 1979. Since 1980, there is an ongoing decrease of the population. These days the population has slowed down until around 1,003,538 in 2002, which means a decrease of about 65,000 people in 25 years. A second problem for the same period is the sprawling of the city area as can be seen in figure 2.

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A third problem is the decrease of the population in the city center and an increase of the population in the outskirts of the city. If we have a look more closely to the demographic situation in the city of Kitakyushu for the periods 1975-1985 and 1985-1995, we can see that on the one hand, there is an increase of the population in the outskirts of Kitakyushu as well as in the neighboring cities. The population increased especially in the south and in the west areas. On the other hand there is a decrease of the population in the center of the city as can be seen in figure 3. There can be imagined several reasons for the shift of the population towards the outskirts of the city. Expensive land prices in the city center has caused the development of residential areas in the outskirts on cheaper land, and this resulted in the destruction of large parts of natural land. Above of that the use of the car has become a necessity and this resulted in the increase of traffic jams, pollution of the air, and the progressing aging of the population in the inner city and the slow down of the shopping area in inner city, among the biggest problems. These phenomena can be seen in almost all Japanese regional cities. The destruction of large natural areas in Kitakyushu has resulted in the loss of many eco-systems in the urban area. The destruction of natural areas, or the so-called urban biotopes did not yet come to an end in Kitakyushu. Some biotopes are still left in the urban area. However the risk is high that even these left over urban biotopes are going to disappear soon in the 21st century. The preservation of these urban biotopes has become an important matter in urban ecological planning. Not only the protection but also the regeneration of them is very important. Based on the former three problems we may say that there is an urgent necessity for the creation of an urban biotope network in the city of Kitakyushu. This network will protect natural land and regenerate the inner city. The basic for the creation of such an urban biotope network will be a historical study of the change of land use. In this research, the change of land use in the Kurosaki Sub center has been investigated. Furthermore, a proposal has been made for the development of 1) an urban biotope network and 2) a compact city concept for the Kurosaki Sub center.

Fig.3. Increase and Decrease of the Population in the City of Kitakyushu (1975-1985 and 1985-1995)
2. Change of Land Use and Location of Building by Building Function in the Kurosaki Sub Center

In this chapter the change of land use for the period 1900-2000, as well as the distribution of the buildings by function for the year 1995 in the Kurosaki Sub center has been investigated. Concerning the change in land use, the following topics has been investigated; 1) the change of the water network, 2) the change of the city area, 3) the change of the industrial area, and 4) the change of the natural or green area. Figure 4 shows the location of the Kurosaki Sub center in the city of Kitakyushu.

The Kurosaki Sub center is located in the most west part of the city, bordered in the north to the so-called Dokaiwan, or Bay of Kitakyushu. In the Edo Period (1603-1868) Kurosaki was important as the last stage town (Shukuba-machi) just before the castle town of Kokura on the Nagasaki Road (Nagasaki Kaido).

These days Kurosaki is the sub center of Kitakyushu, consisting out of a mixture of commercial, residential and industrial area. In this research, the Kurosaki Sub center has been selected as study field because of the following four reasons; 1) Kurosaki’s rapid industrial development in the second half term of the 20th century, 2) its drastically decrease of its population compared to other parts of the city over the last 25 years, 3) the loss of large parts of its green area caused by the industrial developments along the Dokaiwan, and 4) its current importance as the Sub center of the city of Kitakyushu.

In the Kurosaki Sub center, which has no really administrative borders, a zone of 16km² (4km x 4km) with the station of Kurosaki in the center, has been chosen. The change of land use for the years 1900, 1925, 1950, 1975 and 2000 has been investigated as is shown in figure 6. The study of change of land use is based on the historical maps published in Nihon Zushi Taikei, Kyushu I, by Kunizo Asakura, Asakura Shoten, Tokyo 1976. The study for the year 2000 has been based on the digital land use map made by the town planning division of the city of Kitakyushu. Figure 5 is an example of the used historical maps for the years 1900 and 1950.

Because there are no digital land use data available for the period 1900 to 1975, first of all it was necessary to make mesh data for that period. The historical maps have been scanned and then mesh data have been made. A mesh of 20m by 20m has been drawn over the maps. Once the digital data were finished, the area has been calculated of water, green area, city and industrial area. It was fond that the water area decreased from 32.9% in 1900 until 11.4% in 2000. The Dokaiwan has been covered by landfills for the development of industrial area. In Kitakyushu, the industrial area has expanded along the Dokaiwan towards the Sea of Genkai. The city area increased drastically from 2.6% in 1900 until 41.4% in 2000. Because there was no industrial area in 1900, the industrial area increased from 0% in 1990 until 35.5% in 2000. As a result of the expansion of city and industrial area, the green area has decreased drastically from about 64.5% in 1900 until 11.7% in 2000.

In figure 7, the location of the buildings by building function has been investigated. There were only GIS data available for the year 1995. Here we find that nearly all the industrial buildings are located in the north zone of the Kurosaki Sub center, along the Dokaiwan Bay. Nearly more than half of the Kurosaki area consists out of industrial area. The residential area has been formed in the south zone of the Kurosaki Sub center. Furthermore, most of the commercial and office buildings are located in the south zone, and there is especially a concentrated commercial district in front of the Kurosaki station. Another concentration of commercial and office buildings is remarkable along the national way number 3, which runs through the Kurosaki Sub center in east west direction as well as along the national way number 200, in the west part of Kurosaki, running in south-north direction.
Fig. 6. Change of the Land Use in the Kurosaki Sub Center (1900-2000)

Fig. 7. Building Function in the Kurosaki Sub Center (1995)
3. Proposal of an Urban Biotope Network and the Compact City Concept in the Kurosaki Sub Center

Some of the main urban problems in the City of Kitakyushu as described in the introduction are: 1) the still ongoing sprawling of the city area, 2) a continuing decrease of the city population, 3) the decrease of the population in the center of the city and the increase of the population in the outskirts of the city, 4) the loss of much of its natural areas in the outskirts due to the expansion of mostly one family housing residential area.

In this chapter the possibility for the creation of an urban biotope network as well as the proposal of a compact city concept for the Kurosaki Sub center has been investigated as a solution for the former mentioned urban problems.

The Biotope Zone Method:

The proposal of an urban biotope network has been based on the Biotope Zone method as is illustrated in figure 8. In this figure, the urban biotopes are corresponding to the existing green areas in the city. To create an urban biotope network, it is necessary that as much as possible the urban biotopes are physically connected one to each other. However, in urban areas the physical connection is not always possible, and even it is not always necessary that they are physically connected one to each other. Urban biotopes are the habitats or places were wild nature animals could live and move in the city. It can be said that, the bigger in area these biotopes are, the higher the natural values of the urban biotopes will be.

Fig.8. Method of Biotope Zone
Fig. 9. Urban Biotope Network in the Kurosaki Sub Center (2000-2100)

Fig. 10. Proposal of an Urban Biotope Network in the Kurosaki Sub Center
Figure 8 is based on aerial photographs for the year 1999. For that reason, there is a slight difference between the maps of figure 6 and 8. Aerial photographs have been chosen because they are showing the reality, however a negative point is that the smaller green areas were more difficult to distinguish. Urban biotopes as illustrated in the figure exists of 1) the natural area in the city, such as parks, forests, big trees along the roads, and water areas such as ponds, rivers, etc. and 2) a biotope zone, which is the zone used by the animals to move from one biotope to another. The biotope zone corresponds by half the distance an animal can normally move. If two biotopes are connected to each other, the animal can move from one biotope to another. The distance an animal can move is different from one animal to another. In biotope planning an often chosen distance is 200 to 250 m, which is the distance a titmouse flies in between two points. In this study, a distance of 175 m has been chosen.

If we consider the existing green areas in the Kurosaki Sub center, with the Biotope Zone method we find that not all the existing green areas can be connected. Possible area for the creation of new urban biotopes has been investigated, such as open spaces and existing small-unused lot of land. The map in the right under corner of figure 8 shows the existing green areas and the spaces for the creation of new urban biotopes. It has been fond that nearly all the biotope zones can be connected to one each other.

In figure 9, an urban biotope network based on the biotope zone method has been planned for the whole Kurosaki Sub center for the period 2000-2100. Finally, figure 10 shows the Kurosaki Sub center in 2100. A simulation of the change of land use in the 21-century has been made. The general concept was to connect as much as possible the existing water and green areas. The urban biotope network consists of a southern and northern part. The southern part corresponds with the zone of the existing residential and commercial area. The existing green areas have been connected to each other. In the most southern part, large green areas are left around the foot of the mountains. For the industrial area in the northern part, the use of a grid has been introduced. The basic grid chosen was 1x1km for the year 2025, 500x500m for the year 2050, 250x250m for the year 2075 and 125x125m for the year 2100.

In the first phase, a green belt has been proposed in the zones along the Dokaivan and the existing rivers. A green infrastructure network has been introduced in the northern part. In this part of Kurosaki, a further changing of the industrial structure in the 21st century has been supposed. A new industrial structure could be imagined with higher buildings, or this zone could become a residential area as well. This part of the plan corresponds to the compact city concept. The space in between the high buildings has been used to bring a part of the water of the bay more close to the residential area in the south. The space in between the buildings has been used for green zones. From an ecological point of view, the restoration of the ecotone has been emphasized. An ecotone is the border area between two different ecosystems, in this case, the Dokaivan and the industrial area.

4. Conclusion and Prospects for the Future
In this research an investigation of the change of land use in the Kurosaki Sub center and a proposal of an urban biotope network and compact city has been made. The expansion of the industrial and city area has resulted in the destruction of large natural areas in the city. To avoid a further loss of natural area, as well as to preserve the left over natural area, an urban biotope network has been proposed by way of linking existing and increasing new green zones in the urban area. This approach of an urban biotope network can be seen as a solution for the regeneration of old industrial regions into ecological qualitative environments, and can serve as a possible solution for the ecological regeneration towards sustainable development of many ravaged industrial landscapes in Japan. Urban biotope networks have become necessary in densely populated urban areas and must be carried out by an interdisciplinary group of urban planners, architects, geographers, biologists, etc. To realize this urban biotope network, the present situation of natural area in the city must be profoundly investigated. This research has shown the increasing necessity of urban biotope networks as an instrument to avoid a further decrease of natural area in the city. In the following research, the investigation of the possibility of biotope mapping in the Kitakyushu Industrial Area will be undertaken.

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