Crime Occurrence Patterns from the Perspective of Land-use

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ABSTRACT

To improve urban safety there is an increasing social need for environmental design against crime, which is defined as the creation of inconvenient environments or situations for criminal offenders. By using a cluster analysis, we aimed to clarify crime occurrence patterns from the perspective of land-use. Osaka Prefecture was chosen as the study area because it has the highest crime rate in Japan. The results revealed that there are six patterns of crime occurrence, and that cities of medium-level of mixed land-use have the lowest crime rates.

Keywords : Crime prevention, Street crime, Mixed land-use, Cluster analysis.

1. Introduction

Cities are a place where people gather and many industrial activities take place, but they are also a place where increased urban activities tend to lead to increased crime. Thus, crime prevention from an urban planning approach is considered to be an extremely important issue for the creation of a sustainable society. In Japan, based on the concept of crime prevention through environmental design (CPTED), we are focusing on the environment or situations that deter crime and are aiming to reduce the opportunities for crime through proper maintenance, management, and utilization of the physical environment [1]. Land-use is one type of information that can be used to plan the physical environment and has long been hypothesized to have an effect on crime occurrence. According to Jane Jacobs [2], the mixed land-use and the resulting diverseness of the people in the area creates natural surveillance and improves the crime prevention performance of the area. However, because increased diverseness of the people leads to increased anonymity, there is a possibility that mixed land-use causes loss of crime prevention performance. This is because under anonymous circumstances, the identity of an individual is seldom identified by others, mutual interest and the sense of morality are thus weakened, and as a result, deviant behaviors become more likely to occur [3]. When these points are taken into consideration, it can be said that a high-level of mixed land-use is likely to lead to higher crime risk due to increased anonymity and a low-level of mixed land-use is also likely to result in higher crime risk because the natural surveillance will not be formed in this situation.On the other hand, it can be hypothesized that if it is a medium-level of mixed land-use, an adequate level of anonymity and surveillance can be secured and result in low crime risk. Based on this hypothesis, this research aims to reveal the crime occurrence patterns from the perspective of mixed land-use.

2. Research Methodology

2.1 The Study Area and Definition of Mixed Land-use

Using data obtained through e-Stat, the portal site of official statistics of Japan, the crime rate trends in each prefecture of Japan for the 12 years between 2000 and 2011 were studied. The prefecture with the highest crime rate in Japan was Osaka, which had an average 264.40 cases per population of 10,000. Thus Osaka Prefecture (a total of 72 cities, wards, towns, and a village) was chosen as the study area for the analysis. The "use districts" (12 types) and the "no land-use zoning areas" as defined in the City Planning Act of Japan were used as an index of land-use.We assumed that the balance of the ratio (the degree of uniformity) between use districts and no land-use zoning areas in each city, ward, town, and village can indicate mixed land-use.

2.2 Method of Analysis

In this research, firstly a geographic information system (GIS) database on crime rate and the degree of land-use was constructed. The following data on crime rate was obtained from the Osaka Statistical Yearbook and the webpage of Osaka Prefecture: the number of penal code violation incidents and arrests per type of crime and per city, town, and village; the number of penal code violation incidents per type of crime; and the population of each city, town, and village. The crime rate for a population of 100,000 used in this research was calculated based on the number of street crimes (assault, bodily injury, and theft) in 2006 because complete data was obtained for that year. As for the data on land-use, the 2006 National Land Numerical Information data on use districts was downloaded from the National Land Numerical Information download service and the percentage of use districts and loosely regulated areas in each city, ward, town, and village was calculated using GIS. Then, using the land-use data, a cluster analysis was

performed to group cities, wards, towns, and a village in the target area and the degree of uniformity in land-use was calculated for each group. The Simpson's Diversity Index (SDI) shown in equation (1) was used to calculate the degree of the mix and was assumed that the SDI that is closer to 1 indicates a high-level of mixed land use. Lastly, the trend in crime rate for each group was analyzed from the perspective of mixed land-use.

$$SDI_i = 1 - \sum_{i=1}^{S} p_i^2 \quad (1)$$

(pi: area ratio of land-usei in each city, ward, town, and village)

3. Results and Discussion

Table 1 shows the cluster analysis and SDI calculation results. Figure 1 shows the cluster to which each city, ward, town, and village was classified. The number of clusters was set to six, based on the results of the analysis of variance. A smaller cluster number indicates a higher level of mixed land-use and therefore, Clusters 1 and 2 include cities, wards, towns, and a village with a high level of mixed land-use, Clusters 3 and 4 include those with a medium level of mixed land-use, and Clusters 5 and 6 include those with a low levelofmixedland-use.
Figure 2 compares the street crime rates in each cluster. Since Cluster 3 with a medium level of mixed land-use is shown to have a particularly high crime rate, the result may seem to reject the hypothesis of this research but this is probably due to the large effect of the extremely high percentage of commercial areas in Cluster 3. Therefore, the crime rate for each cluster excluding Cluster 3 was compared and found that Cluster 1 with a high level of mixed land-use to be the cluster with the highest crime rate across all crime types. Cluster 6 with a low level of mixed land-use had the second highest crime rate for assault and theft, and Cluster 2 with a high level of mixed land-use had the second highest crime rate for bodily injury. On the contrary, Cluster 4 with a medium level of mixed land-use had a low crime rate regarding all crime types.

4. Conclusions

From the perspective of land-use, this research revealed the pattern of crime occurrence based on the following research hypothesis: areas with a medium level of mixed land-use have comparatively lower crime rate. The result showed that cities, wards, towns, and a village with a medium level of mixed land-use have low crime rate and supported the research hypothesis. Moreover, the result indicated that crime occurrence patterns differ depending on the type of crime. However, when the fact that the percentage of commercial areas in an area has a large effect on crime rate is considered, it must be said that crime risks cannot be discussed solely by the level of mixed land-use.

5. References

[1] Kinashi, M. (2014), "Development of Crime Risk Assessment for Community Safety Design," Proceedings of 9th International Symposium on Lowland Technology, 9, pp.677-684.
[2] Jacobs, J. (1961), "The death and life of great American cities," Random House, 458pp.
[3] Nagai, Y. (1986). "Deviant behavior and "anonymity" of the city - the possibility of concealment and discovery," Sociology, 30(3): pp.77-96 (in Japanese).

Figure 1. Cities, wards, towns, and a village and their belonging clusters

Table 1. Cluster analysis and SDI calculation results

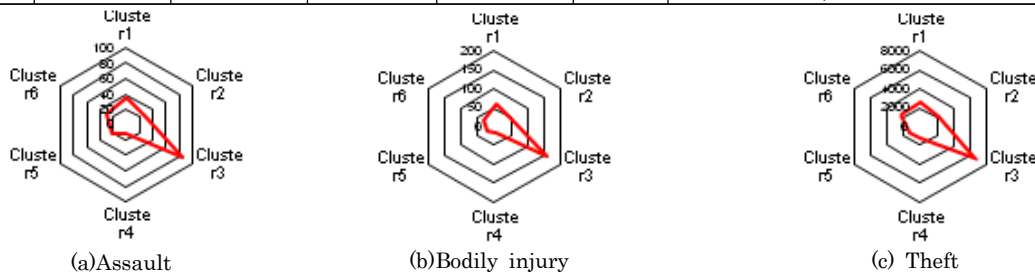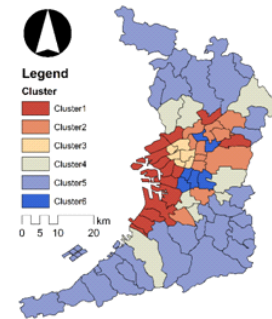| Cluster	Percentage of land area per use district				SDI	Characteristic	Number of cities
	Residential areas	Commercial areas	Industrial areas	No land-use zoning areas			
1	30.6	7.8	45.0	16.6	0.671	High-level of mixed land-use (Mainly industrial areas)	14
2	55.7	9.3	22.8	12.2	0.614	High-level of mixed land-use (Mixed residential and industrial areas)	11
3	23.3	57.5	13.3	5.9	0.594	Middle-level of mixed land-use (Mainly commercial areas)	6
4	60.6	5.1	10.6	23.7	0.563	Middle-level of mixed land-use (Mainly residential areas)	8
5	25.5	1.0	5.1	68.4	0.464	Low-level of mixed land-use (Mixed use district)	27
6	74.3	11.7	9.5	4.4	0.423	Low-level of mixed land-use (Mainly residential areas)	6

(a)Assault (b)Bodily injury (c) Theft

Figure 2. Crime rate per crime type and cluster (per 100,000 population)