A Study on Appropriate Selection of Final Waste Disposal Sites

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1. Introduction

Some wastes are recycled for creating a recycling society these days, but most remain buried in the ground or burned. In other words, construction of final waste disposal sites can not be avoided. This study presents a method for determining a final waste disposal site from the three perspectives of physical, social, and environmental factors. The area of study was Okayama Prefecture. We used 1km mesh data to estimate spatial distribution. The analysis was performed easily using the network ability of GIS (geographic information system).

2. Exclusionary Rule

An exclusionary approach begins by identifying areas that are inappropriate for use because they have particular land features such as endangered species or wetlands. Areas which judged to be inappropriate by exclusionary criteria in table1 were excluded from candidate sites for the facility.

Table 1 Exclusionary criteria

Item	Exclusionary criteria
Hydrology	river, flood-prone area
Landform	fault area, steep slope area, collapse area, landslide area
Ecology	nature conservation area, wildlife refuge
Location	major road, airport
Land use	natural park, use district
Sociality	cultural resource

3. Factors Considered in Siting

(1) Economic factor

The 'waste disposal flow chart' announced by the Ministry of the Environment in 2003 is shown in Fig.1. Optimal location is considered from this waste disposal network. If a new final disposal site is constructed, the area that minimizes target function will be selected as that optimal site. The target function is

$$f_{\mathrm{EF}} = \sum_{a \in At_2} d \cdot r \cdot x_a \cdot TC_a + \sum_{a \in At_3} (1-d) x_a \cdot TC_a + \sum_i TP_i \cdot \delta_i \qquad (1)$$

where the right side indicates transport cost of remaining waste, direct transport cost of final disposal, and the cost for locating the final disposal site facility in turn. Other costs were not considered because they do not change greatly according to location.

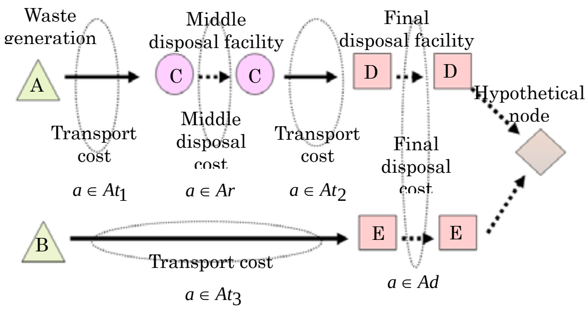

Fig.1 Waste disposal flow chart

(2) Social factor

The results of survey which was conducted in Saitama Prefecture were used to analyze social factors. We have analyzed using covariance structure analysis of statistical method to understand awareness of residents toward the final waste disposal facility. Fig.2 shows the covariance structure model.

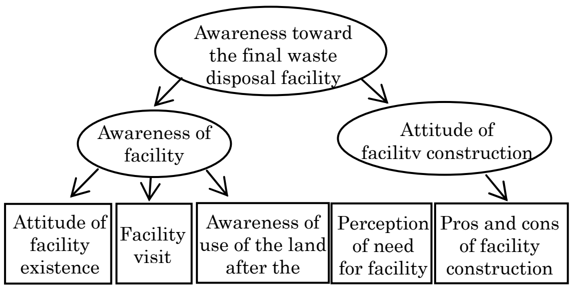

Fig.2 Covariance structure model

Covariance structure model by each age group was constructed from recoding data. We assume that awareness structure of whole nation is equal, and calculated awareness of residents in Okayama Prefecture using following function,

$$f_{\mathrm{SF}} = 1 - \sum_k I_{k,i} \frac{P_{k,i}}{T_i} \quad (2)$$

where k is age group's number, i is mesh number, I is awareness of residents, T is total population, and P is the population of age group. The area that minimizes value of this function will be selected as that optimal site. It means degree of public opposition.

(3) Environmental factor

Safety aspects must be also considered with economic and social factors. The regions that have final waste disposal facilities might be exposed to dangers through alteration and degradation of impermeable liners, leaching of contaminated water into groundwater following precipitation, and degradation of the disposal site by an earthquake. The considered environmental factors are average attitude, annual rainfall, gradient, and ground hardness.

4. Calculating weights of each factor by AHP

In order to consider simultaneously three factors, we need relative weights for each factor. In this study, the relative weights were obtained from AHP (Analytic Hierarchy Process). The AHP is a structured technique for helping people deal with complex decisions. We made a pairwise comparison matrix for each factor, and calculated eigen values and vectors. The elements of the eigen vector corresponding maximum eigen value are relative weights for each factor.

Table 2 Relative weights for each factor

Factor	Weight
Environmental factor	0.540
Economic factor	0.297
Social factor	0.163

Factor	Weight
Ground hardness	0.467
Gradient	0.277
Average attitude	0.160
Annual rainfall	0.095

5. Selecting final candidate site

The site selection model based on relative weights of each factor is

$$f(y) = \sum_{i=1}^{n} w_i f_i \quad (3)$$

where n is the number of factors, w_i is weight of i factor, and f_i is the standardized value of i factor. The area that minimizes value of this function will be selected as that optimal site. Fig.3 shows the proposed final candidate sites.

Fig.3 Proposed final candidate site

6. Conclusion

Determining the location of a final waste disposal facility is an important component of the waste management process. Three factors considered in this study must be considered simultaneously when determining the location. This study constructed site selection model to find appropriate location for the facility, and proposed several candidate sites.

References

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