A STUDY ON LAND SELECTION AND REGIONAL DEVELOPMENT FOR CLOSED SYSTEM DISPOSAL FACILITIES

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ABSTRACT

Closed System Disposal Facilities(herein after called “CSDF”)is intercepted by covering facilities and seepage control facilities from outside environment, and has the following features.

①Scattering of waste and diffusion of a bad smell can be prevented. ②Neither the quantity of seepage water nor reclamation work is influenced by the weather. ③This image is better than a conventional opened-type landfill site (herein after called “OPLS”) because it hides waste from outside. ④It is easier to obtain the consent of residents about the construction of a landfill site. ⑤It can use for the storage facilities for recycling.

On the basis of these, the authors studied methods of land selection of CSDF and the practical regional developments which are based on the features of CSDF and OPLS in terms of cost reductions of whole landfill systems.

Keywords：Land Selection，Regional Development，Closed System Disposal Facilities

INTRODUCTION

In recent years, a number of regional development projects have been under way in Japan for such intermediate processing facilities of waste as incineration facilities and recycling facilities for the measure against dioxin, economic and efficiency at the waste disposal.

However, there have been few intensive and extensive projects with landfills. In addition, an increasing number of local governments are sharing and managing more than one landfill as a result of recent mergers of cities and towns promoted under a government incentive.

Under these circumstances, it is becoming more important to select an optimal development pattern when a local government is to plan the construction of regional landfill. A development pattern refers to a form of development of a landfill based on considerations of regional conditions specific to each local government. The selection of a development pattern is to determine the number of facilities to be built, the scale, and the basic structure of a landfill

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(OPLS or CSDF).

Once a development pattern is selected, the site for the landfill needs to be determined. Conventionally, land selection is based on the development of an OPLS. Therefore it is required now to select a site for a CSDF as well, this type of facility, having a number of advantages over the OPLS, is increasingly employed on various scales and under a variety of local conditions.

Focusing on the cost reduction issue for landfill systems as a whole, the authors had conducted research on the method of selection for optimal development pattern under a regional development project and the land selection approach applicable to the CSDF, as well as the OPLS.

1. A STUDY OF THE METHOD TO SELECT AN OPTIMAL DEVELOPMENT PATTERN AND ITS CASE STUDY UNDER A REGIONAL LANDFILL DEVELOPMENT PROGRAM

This study discusses a classification and evaluation method of regional landfill development patterns. It was considered with regional and evaluative conditions in a case study for some model areas.

(1) CLASSIFICATION OF DEVELOPMENT PATTERNS

The regional landfill development patterns can be classified as centralized and decentralized types. In a centralized pattern, a single landfill is developed, while in a decentralized pattern, multiple landfills are constructed.

A total of 10 patterns are obtained when landfills are classified further by basic structure (Table 1).

(2) EVALUATION ITEMS

When landfills are developed at extended regions, evaluation items are required to reflect specific regional conditions for selecting an optimal development pattern with consideration of economic, efficiency, and environmental preservation.

Evaluation items are determined by regional characteristics of a local government or an extended association of local governments, locational conditions, and social conditions. In this study, economy and efficiency are set as direct cost reduction factors and for indirect cost reduction factors, living environment, natural environment, safety, consensus building, and others are fixed (Table2).

Table 1 Classification of development patterns

	No.	Classification
Centralized (A single facility)	1	OPLS
	2	CSDF
	3	OP-CS combined disposal facilities
Decentralized (multiple facilities)	4	OPLS
	5	CSDF
	6	OP-CS combined disposal facilities
	7	OPLS + CSDF
	8	OPLS + OP-CS combined disposal facilities
	9	CSDF + OP-CS combined disposal facilities
	10	OPLS + CSDF + OP-CS combined facilities

Table 2 Evaluation items

Evaluation items		
Direct cost reduction factor	Economy	Construction costs
		Maintenance and management cost
		Construction costs + maintenance management cost
	Efficiency	Efficiency in maintenance management
Indirect cost reduction factor	Living environmen	Maintainability of the living environment
	Natural environment	Maintainability of the natural environment
	Safety	Risks of potential pollution and disasters
	Consensus building	Ease of consensus building for landfill
	Others	Smoothness of development
		Disaster debris
		Measure for returning benefits to community
		Combination with existing facilty

Table 3-1 Evaluation criteria

Evaluation items			Evaluation details		Evaluation criteria: Basic structure (OPLS/CSDF): OPLS	Combined type	CSDF	Landfill system (Centralized /Decentralized): A single facility	Dual facilities	3 or more facilities	Explanations	
Direct cost reduction factor	Economy	construction cost	(1)Economy in construction cost by basic structure(OPLS/CSDF)		A	B	C	-	-	-	OPLS /CSDF	The OPLS is given higher marks when the OPLS and CSDF are of equal scale.
			(2)Economy in construction cost by centralized/decentralized landfill		-	-	-	A	B	C	Centralized /decentralized	The centralized landfill system is given higher marks because it has a greater advantage of scales.
		Maintenance manegement cost	(3)Economy in maintenance management cost by basic structure(OPLS/CSDF) and by centralized/desentralized landfill		C	B	A	A	B	C	OPLS /CSDF	The CSDF is given higher marks because it needs only a smaller water treatment facility, and without the need for covering soil on the same day which enables periodical covering operation for daily carrying.
											Centralized /decentralized	The centralized landfill system is given higher marks because it does not require distributed maintenance manegement activities while having an advantage of scales.
			(4)Superiority of a centralized/decentralized landfill by population (the scale of the landfill)	Up to 50,000	-	-	-	A	C		Centralized /decentralized	In case of a small population, the centralized landfill system is given higher marks because it requires only a smaller scale of landfill, thus lower cost for maintenance management of facilities such as water treatment which dilutes the advantage of the decentralized landfill system. In case of a large population, the decentralized landfill system is given higher marks because it can reduce the scale and maintenance management cost of each landfill.
				50,000 to 100,000								
				100,000 to 200,000	-	-	-	B	B			
				2000,000 or more	-	-	-	C	A			
		construction cost + maintenance management cost	(5)Economy by amount of railfall	Up to 1,500(㎜/year)	A	B	B	-	-	-	OPLS /CSDF	In case of a heavy rainfall area, the CSDF is given higher marks because it can accept larger amount of rainfall without enlarging the size of water treatment facility, thus economy in construction cost and in maintenance management cost comparing with the OPLS which requires larger size of facility to accept it. In case of a low rainfall area, the difference of the size of required water treatment facility between the OPLS and CSDF is smaller, thus the OPLS is given slightly higher marks as its construciton cost is lower than the CSDF.
				1,500～1,900(㎜/year)	B	B	A	-	-	-		
				1,900 or more(㎜/year)	C	B	A	-	-	-		
	Efficiency	Efficiency in maintenance management	(6)Size of the area covered by waste collection services	Small area(up to 400k㎡)	-	-	-	A	B	C	Centralized /decentralized	The larger the area, the greater distance to an intermediate processing facility, thus a decentralized landfill system having multiple intermediate processing facilities is given higher marks as it enables effective transportation. The smaller the area, the shorter distance to an intermediate processing facility, thus a centralized landfill system is given higher marks as there is little advantage of decentralization.
				Medium-sized(400～1,000k㎡)	-	-	-	B	B	B		
				Large area(1,000k㎡ or more)	-	-	-	C	B	A		
			(7)Ease of direct transportation to the landfill		-	-	-	C	B	A	Centralized /decentralized	Irrelevant to the size of areas, decentalization of multiple facilities is given higher marks because the distance of direct transportation becomes shorter.
			(8)Operational efficiency affected by snowfall	Area with little snowfall	A	A	A	-	-	-	OPLS /CSDF	A heavy-snowjall area is defined as a desighated area for the special mesures law for the area of very heavy snowfall while a low-snowfall areas means an areas with 100㎝/year or more of the maximum depth of snowfall but not designated for the law. Other areas are defined as areas with little snowfall. The CSDF is given higher marks because probapility of operational suspention in case of the OPLS.
				Low-snowfall area	B	B	A	-	-	-		
				Heavy-snowfall area	C	B	A	-	-	-		

※ Evaluation and standard value : A=1.0, B=0.7, C=0.3

Table 3-2 Evaluation criteria

Evaluation items			Evaluation details		Basic structure (OPLS/CSDF): OPLS	Basic structure (OPLS/CSDF): Combined type	Basic structure (OPLS/CSDF): CSDF	Landfill system (Centralized /Decentralized): A single facility	Landfill system (Centralized /Decentralized): Dual facilities	Landfill system (Centralized /Decentralized): 3 or more facilities	Explanations	
Indirect cost reduction factor	Living environment	Maintainability of living environment	(9) Degree of impact of landscape changes		C	B	A	C	B	A	OPLS /CSDF	The CSDF is given higher marks because it can preserve landscape with its covering facilities and is free from crow damage.
											Centralized /decentralized	The centralized landfill system is given lower marks because it causes a substantial landscape change due to its size.
			(10) Maintainability of the living environment affected by crow damege and waste dispersion		C	B	A	C	B	A	OPLS /CSDF	The OPLS is given lower marks because it is subject to damage from crows, harmful.insects, animals and also from waste dispersion.
											Centralized /decentralized	The decentralized landfill system is given moderately higher marks because each landfill is small and also because the system can better preserve the environment.
			(11) Maintainability of the living environment along roadways used by waste-carrying vehicles		-	-	-	C	B	A	OPLS /CSDF	※No evaluation has been made because in case of the OPLS, maintainability of the living environment along roadways is dependent on the number of vehicles to carry covering soil, thus
											Centralized /decentralized	The centralized landfill system is given lower marks because waste-carrying traffic concentrates on a specific road.
			(12) Effects on the utilization of neighboring land		C	B	A	C	B	A	OPLS /CSDF	The OPLS is given lower marks because uncovered waste and larger amount of treated water cause a substantial landscape change, thus it brings a poorer image of landfill compared with the
											Centralized /decentralized	The centralized landfill system is given lower marks because the larger each landfill is, the more substantial impact it has on the utilization of neighboring land.
	Natural envionment	Maintainability of natural environment	(13) Degree of impact of changes in the natural environment		C	B	A	C	B	A	OPLS /CSDF	The CSDF is given higher marks because it is free from damage from crows, harmful insects and animals, thus more capable of preserving the natural environment.
											Centralized /decentralized	The decentralized landfill system is given higher marks because the smaller each landfill is, the less damage it suffers from crows, harmful insects and animals.
			(14) Effects on downstream areas of change in treated water discharge		C	B	A	C	B	A	OPLS /CSDF	The CSDF is given higher marks because it can control the generation of leachate.
											Centralized /decentralized	The decentralized landfill system is given higher marks because a single landfill generates a smaller amount of leachate, thus affecting its downstream waters.
	Safety	Risk of potential pollution and disasters	(15) Degree of disasters and risks caused by torrential rainfalls, earthquakes, and other events		C	B	A	C	B	A	OPLS /CSDF	In case of a torrential rainfall, the CSDF is given higher marks because it can control overflows of retained water. In case of a gale-force wind, the OPLS is given slightly lower marks due to the seriousness of damage it suffers such as waste dispersion and breakage of seepage control work while the CSDF is still not free from damage such as breakage of the roof. In case of an earthquake, both the OPLS and CSDF are given low marks due to the damage they suffer on seepage control work and on their foundation base while additional damage is expected on the roof in case of the CSDF. Overall, the CSDF is given higher marks in this evaluation item.
											Centralized /decentralized	The decentralized landfill system is given higher marks because the degree of a disaster or risk is diluted.
			(16) Degree of risks and underground water pollution caused by water leakage		C	B	A	C	B	A	OPLS /CSDF	The CSDF is given higher marks because it can reduce pollution in underground water by controlling the amount of sprinkled water.
											Centralized /decentralized	The decentralized landfill system is given higher marks because the degree and the risk of pollution in underground water are diluted.
	Consensus building	East of consensus building for development	(17) Ease of consensus building by basic structure	Few urbanized areas (up to 100people/k㎡)	B	B	A	-	-	-	OPLS /CSDF	Ease of consensus building, the OPLS is given lower marks where there are many urbanized areas or in a community where there is strong resistance to a regional landfill.
				Moderate number of urbanized areas (100～1000people/k㎡)	C	B	A	-	-	-		
				Many urbanized areas(1000k㎡ or more)	C	C	A	-	-	-		
			(18) Ease of consensus building and land acquisition by Centralized/decentralized landfill system	Few urbanized areas (up to 100people/k㎡)	-	-	-	A	B		Centralized /decentralized	The cen tralized landfill system is given higher marks because the more urbanized areas, the more difficult to manage building lots in these areas, however, both centralized and decentralized landfill systems are given lower marks in areas with more than 1,000 people/k㎡
				Moderate number of urbanized areas (100～1000people/k㎡)	-	-	-	B	C			
				Many urbanized areas(1000k㎡ or more)	-	-	-	C	C			

※ Evaluation and standard value : A=1.0, B=0.7, C=0.3

Table 3-3 Evaluation criteria

Evaluation items			Evaluation details				Evaluation criteria: Basic structure (OPLS/CSDF) OPLS	Combined type	CSDF	Landfill system (Centralized /Decentralized) A single facility	Dual facilities	3 or more facilities	Explanations	
Indirect cost reduction factor	Others	Smoothness of development	(19) Smoothness of development by centralized/decentralized landfill system			In case development of landfil is conducted continuously	-	-	-	C	A		Centralized /decentralized	In case of an existing landfill is developed alternately or in rotation with new landfills, the decentralized landfill system is given higher marks because it is advantageous in effect of investment and in timing of development. The decentralized landfill system is given higher marks in a community that is more in favor of a decentralized one for its historical background such as integration of administrative regions or corporate disposal of waste among regions. The centralized landfill system is given higher marks in a community that is more in favor of a
						In case deveopment of landfill is stagnant	-	-	-	A	C			
		Disaster debris	(20) Ease of acceptance and disposal of disaster debris				C	B	A	C	B	A	OPLS /CSDF	In case disaster debris needs to be kept temporarily, the CSDF is given higher marks because its covering facilities keep it from being exposed to the natural environment, thus enables other activities in the same landfill even on a rainy day.
													OPLS /CSDF	Although the centralized landfill system is more advantageous both in carrying and disposing disaster debris, the decentralized landfill system is given higher marks because it can reduce the amount of debris for each landfill and facilitate its acceptance.
		Measure for returning benefits to community	(21) Effectiveness of measures for returning benefits to the community by basic structures				C	A	B	-	-	-	OPLS /CSDF	If an effective development policy for returning benefits by utilizing the vestige site is suggested in advance, the type of basic structure which is specified in the policy is given higher marks in any cases. If no specific policy is suggested in advance, the OP-CS combined development pattern is given higher marks because it allows a broader choice in the utilization of the vestige site as the facility can be used both for indoor and outdoor.
		Combination with existing facility	(22) Combination with existing landfill	In case the existing landfill is OPLS	Combination by division of waste	Existing landfill with substantial remaining waste diposable capacity	C	B	A	-	-	-	OPLS /CSDF	The CSDF is given higher marks because division of waste enables efficient and long-lasting use of landfill and it also dilutes the risk of landfill while there is little advantage in division of waste in the case of the OPLS.
						Existing landfill with 5 to 10 years of remaining service period	B	B	A	-	-	-		The OPLS is given intermediate marks because division of waste is a stage for proper use of landfill in the next generation. The CSDF is given higher marks because division of waste enables efficient and long-lasting use of landfill and it also dilutes the risk of landfill.
						Existing landfill with up to 5 years of remaining service period	B	B	A	-	-	-		
					combination by facility sharing	Share of basic facilities is possible	B	B	A	-	-	-		The CSDF is given higher marks because it requires a smaller scale of additional facilities to be combined with existing landfill compared with the case of the OPLS.
						Only the share of supplementary facilities is possible	A	B	B	-	-	-		The OPLS is given higher marks because it does not require operational changes in disposal system while the CSDF is given slightly lower marks due to some operational changes it needs.
						No sharing of facilities	C	C	C	-	-	-		Both the OPLS and the CSDF are given low marks because there is no advantage of combination with existing landfill.
				In case the existing landfill is CSDF	Combination by division of waste	Existing landfill with substantial remaining waste diposable capacity	A	B	B	-	-	-		The OPLS is given higher marks because division of waste enables efficient and long-lasting use of landfill and it also dilutes the risk of landfill. The CSDF is given intermediate marks because there is little advantage of efficient or long-lasting use of landfill while division of waste still enables safe and controlled management of the landfill by changing its management methods.
						Existing landfill with 5 to 10 years of remaining service period	A	B	B	-	-	-		
						Existing landfill with up to 5 years of remaining service period	A	B	B	-	-	-		
					combination by facility sharing	Share of basic facilities is possible	C	B	B	-	-	-		The OPLS is given lower marks because it requires a larger scale of additional facilities to be combined with existing ladfill, thus impractical. In case of the CSDF, the scale of additional facilities it requires is smaller, thus rather practical and given relatively higher marks.
						Only the share of supplementary facilities is possible	B	B	A	-	-	-		The CSDF is given higher marks because it does not require operational changes in disposal system while the OPLS is given slightly lower marks due to some operational changes it needs.
						No sharing of facilities	C	C	C	-	-	-		Both the OPLS and the CSDF are given low marks because there is no advantage of combination with existing landfill.

※ Evaluation and standard value : A=1.0, B=0.7, C=0.3

Table 4 Comparative evaluation of development patterns

An explanation for Table4

1)Ten development patterns can be evaluated and compared quantitatively by totaling point with given weights.
2)Inserting required data into "Basic data of the target area" (gray cell)
3)Each quality will be calculated based on their conditions evaluated on standard values A(1.0), B(0.7), C(0.3) as shown in separate table.
4)Each assessment will be calculated by Σ(assessment)=Σ(points)×(quality)

Basic data of the target area

Name of the		Name of the					
Population		Area(km^2)		Population density (People/km^2)		Annual rainfall (㎜/year)	
depth of snow (㎝/year)				Amount of snowfall(1:Area with little snowfall, 2:Low-snowfall area, 7:Heavy-snowfall area)			
Existing landfill	Basic structure of the existing landfill(1:OPLS, 2:CSDF, 3:No existing landfill)			Remaining service period(year)		Range of facilities to be shared(1:Basic facilities, 2:Supplementary facilities,	

	Evaluation items		Evaluation details	Subject of evalution		Points(weight)		Centralized landfill system (single facility)						Decentralized landfill system(multiple facility)													
								Pattern① OPLS		Pattern② CSDF		Pattern③ Combined type		Pattern④ OPLS		Pattern⑤ CSDF		Pattern⑥ Combined type		Pattern⑦ OPLS + CSDF		Pattern⑧ OPLS + Combined type		Pattern⑨ CSDF + Combined type		Pattern⑩ OPLS+CSDF+Combined type	
				Basic structure (OPLS/CSDF)	Landfill system (Centralized/Decentral			Quality	Assessment	Quality	Assessment	Quality	Assessment	Quality	Assessment	Quality	Assessment	Quality	Assessment	Quality	Assessment	Quality	Assessment	Quality	Assessment	Quality	Assessment
Direct cost reductionfactor	Economy	construction cost	(1)Economy in construction cost by basic structure(OPLS/CSDF)	○		28	4																				
			(2)Economy in construction cost by centralized/decentralized landfill		○		10																				
		Maintenance manegement cost	(3)Economy in maintenance management cost by basic	○	○		8																				
			(4)Superiority of a centralized/decentralized landfill by population (the scale of the landfill)		○		6																				
	Efficiency	construction cost + maintenance management	(5)Economy by amount of railfall	○		21	6																				
		Efficiency in maintenance management	(6)Size of the area covered by waste collection services		○		7																				
			(7)Ease of direct transportation to the landfill		○		2																				
			(8)Operational efficiency affected by snowfall	○			6																				
			Sub Total 1			49																					
Indirect cost reduction factor	Living environment	Maintainability of living environment	(9) Degree of impact of landscape changes	○	○	12	3																				
			(10) Maintainability of the living environment affected by crow damege and waste dispersion	○	○		2																				
			(11) Maintainability of living environment along roadways used by waste-carrying vehicles		○		3																				
			(12) Effects on the utilization of neighboring land	○	○		4																				
	Natural envionme	Maintainability of natural	(13) Degree of impact of changes in the natural environment	○	○	7	3																				
			(14) Effects of downstream areas of change in treated water discharge	○	○		4																				
	Safety	Risk of potential pollution and disasters	(15) Degree of disasters and risks caused by torrential rainfalls, earthquakes, and other events	○	○	12	6																				
			(16) Degree of risks and underground water pollution caused by water	○	○		6																				
	Consensus building	East of consensus building for development	(17) Ease of consensus building by basic structure	○		9	5																				
			(18) Ease of consensus building and land acquisition by centralized/decentralized landfill system		○		4																				
	Others	Smoothness of development	(19) Smoothness of development by centralized/decentralized landfill system		○	11	3																				
		Disaster debris	(20) Ease of acceptance and disposal of disaster debris	○	○		2																				
		Measure for returning benefits to	(21) Effectiveness of measures for returning benefits to the community by basic structures	○			3																				
		Combination with existing	(22) Combination with existing landfill	○			3																				
			Sub Total 2			51																					
			Total			100																					

(3) AN EVALUATION METHOD OF DEVELOPMENT PATTERNS

To evaluate the development patterns, the evaluation items were categorized into 7 evaluation criteria as shown in Table 3. In addition, giving priority to these criteria in consideration of regional characteristics enhances reliability of the selection of an optimal development pattern.

Each development pattern is marked by criteria and evaluation items. Development patterns can be evaluated and compared quantitatively by totaling point with given weights. (Table 4).

(4) CASE STUDY OF AN OPTIMAL DEVELOPMENT PATTERN SELECTION FOR MODEL AREAS

Seventeen model areas have been selected and surveyed on a comparative evaluation for a case study of optimal development pattern selection. The model areas have been selected by referring to population, area size, as well as these areas' multiple priorities (Table 5).

The comparative evaluation of development patterns as shown in Table 4 has been discussed in three cases where the ratio of the point of the direct cost reduction factor (economy and efficiency) is approximately equal to the indirect cost reduction factor (maintainability of environment, etc), and each ratio of these.

Table 5 Selected model areas

		area population(people)			
		up to 5,000	50,000 ～ 100,000	100,000 ～ 200,000	200,000 or more
are size(km^2)	up to 400	Q assoc.	N assoc. O city P assoc.	M city	J city K city L city
	400 ～ 1,000	I assoc.	H assoc.	F assoc. G assoc.	E city
	1,000 or more	—	D assoc.	B assoc. C assoc.	A assoc.

In summary, these properties for optimal development patterns in this case study are shown below.

① A single facility is given higher marks for smaller areas and multiple facilities higher marks for larger areas.

② Higher marks in the case are given for a single facility with consideration of the economy and efficiency and multiple facilities with consideration of maintainability of environment. (When maintainability of environment is considered, the number of facilities is large . When economy and efficiency are considered, the number of facilities is small.)

③ OPLS is given higher marks when construction cost's point is high.

④ Evaluation of CSDF is given higher marks than half the number of evaluation items. Therefore, development patterns which include CSDF have higher marks.

This case study is one of the examples and also it is a method of evaluation for qualitative development images. The evaluation items, criteria and points are reflected by the opinions of participants and residents. It is possible to select development patterns economically and for their maintainability at the areas. It suggests extremely objective development patterns by practicing of the selection method. It is easy to advance an agreement form of construction promotion by evaluation items reflecting the opinions of residents and practicing criteria.

2. THE LAND SELECTION METHOD FOR CSDF

Conventional land selection has practiced by basis on the hypothesis of OPLS development. However, the features of OPLS and CSDF are different, so in the case of CSDF development, it has been considered that evaluation items and point by the features are important. Also five proposed sites have been selected in the model areas. Five proposed sites have been practiced for optimal evaluation by different type of landfills by the evaluation items and point. It has considered the land futures by each type of landfill.

(1) The Landfill's Land Selection Flow

A general land selection flow is shown in Figure 1.

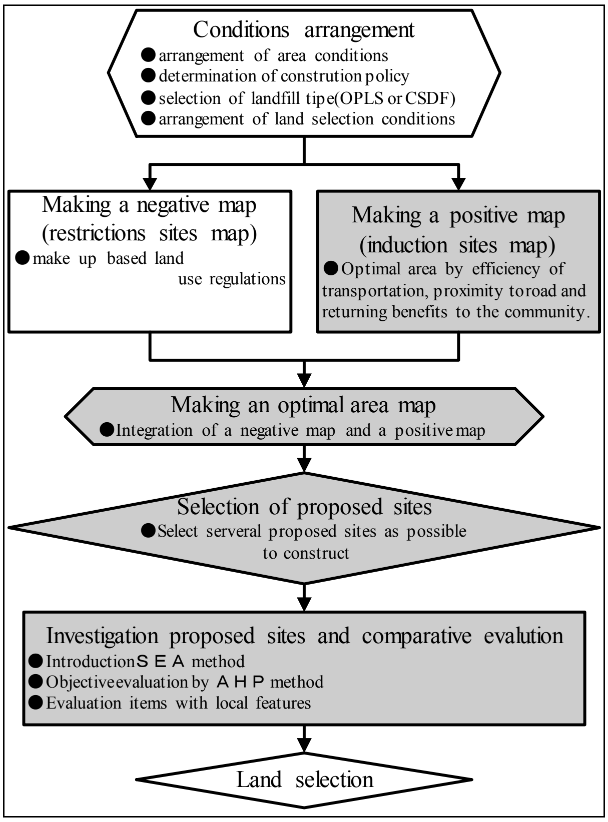


Figure 1 The Landfill's Land Selection Flow

The leading site conditions for making positive map, there are items shown in Table 6 on each type of landfill. The area of leading site for CSDF is larger than OPLS.

(2) Evaluation items and priorities

Table 7 shows the evaluation items of proposed sites and the points considered in OPLS and CSDF. Some of the criteria and points are common between OPLS and CSDF, some are different in importance and some show some opposite results in their evaluation. Also, it should be noted that the evaluation shown is an example. A real case needs to be reviewed. CSDF and OPLS are evaluated individually by these evaluation tables.

Table 6 Examples of site leading conditions for CSDF and OPLS

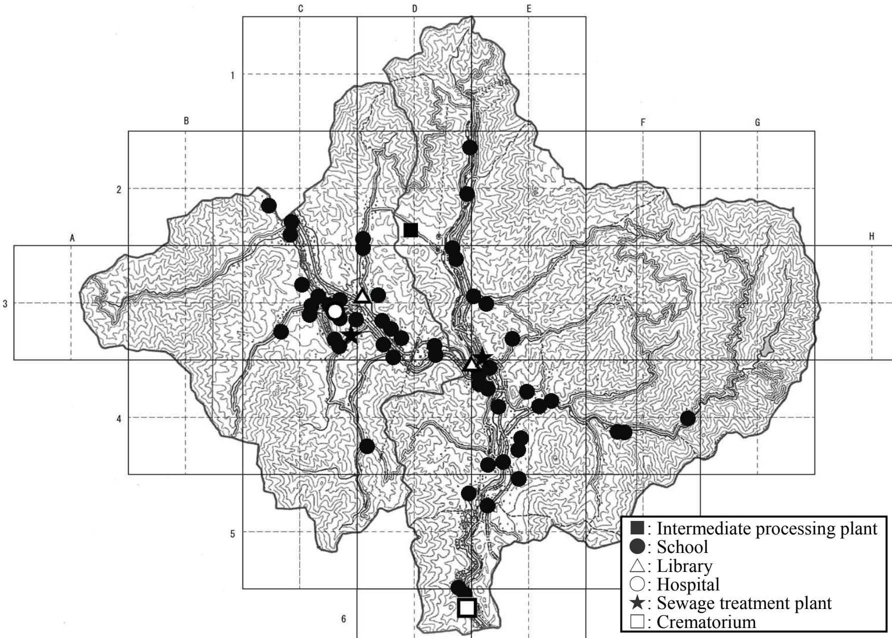
Types	Leading a site conditions
OPLS	① Transportation efficiency is highly areas from intermediate processing facilities and the source of incidence.
CSDF	① Transportation efficiency is highly areas from intermediate processing facilities and the source of incidence. ② Proximity to road areas with highly environmental preservation and good images of scenery. ③ Leading a site area by useful covering equipment(landfill sites or precedence sites) ・Proximity to urban district areas (indoor sports facilities, recycling facilities, emergency refuge places, public lending warehouses) ・Farmland areas (warehouses of agriculture) ・Industry areas and near urban district areas (material warehouses)

Table 7 Examples of evaluation items and points for OPLS and CSDF

Evaluation items			Basic structure (priorities)			
			OPLS		CSDF	
Efficiency		Ease of acquisition cover soil	5	3	4	2
		Distance of access road		2		2
Economy		Construction costs	35	15	35	15
		Infrastructure construction costs		10		10
		Maintenance management costs		5		5
		Efficiency of waste collection services		5		5
Sites features		Efficiency of landfill	14	3	13	2
		Efficiency of ultimate land		3		3
		Irrigation situation		8		8
Environment conditions	Natural conditions	Ground strength	14	2	18	4
		Groundwater level		2		4
		Seclusion from active fault		5		5
		Ground stability		5		5
	Social conditions	Land use situation	32	4	30	2
		Deposit cultural assets		2		2
		Residence distribution		2		1
		Facilities distribution		19		20
		Induction sites		5		5
Total			100		100	

(3) A case study of land selection at model areas

A case study was surveyed at model areas as shown in Figure 2.



①Population : 70,000 people
②Area : 500km²
③Population density : 200 people/km²
④Rainfall : 1,500mm/year
⑤Intermediate treatment plant : 1 facility
⑥No existing landfill
⑦Development pattern and Evaluation points
CSDF 1 facility (76.00points) 1st/10
OPLS 1 facility (59.00points) 9th/10
⑧Facility scale
Landfill capacity:50,000m³
Landfill area :10,000m²

Figure 2 Model areas and conditions

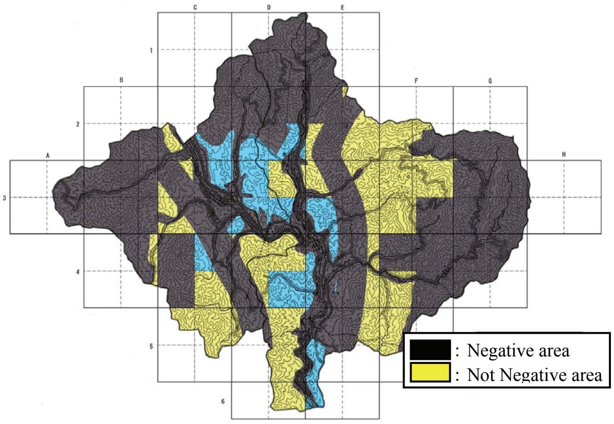


Figure 3 Negative area map

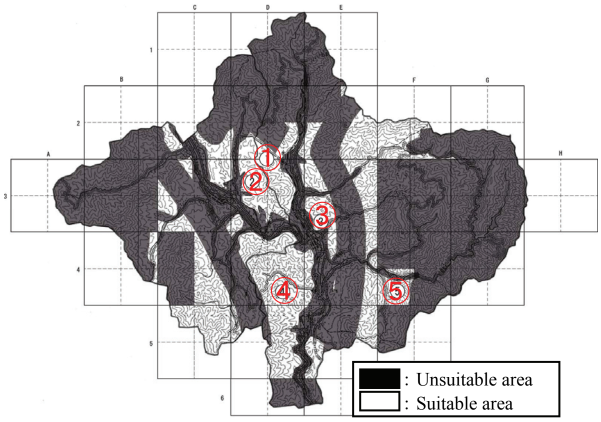


Figure5 Suitable areas map and five proposed site

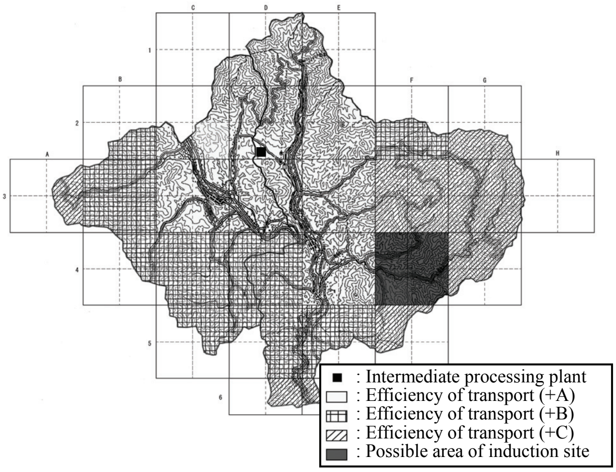


Figure 4 Positive area map

Firstly, the land selection flow was followed as shown in Figure 1. A hypothesis of a negative map (Figure 3) and a positive map (Figure 4) were compiled, then five proposed sites were selected (Figure 5).

(4) Results of proposed sites evaluation in model areas

Table 8 shows results of evaluation for each proposed site by comparative evaluation with various conditions of each proposed and selected site.

According to the results of the evaluation, proposed site № ① (proximity to intermediate processing facilities)is the highest point in CSDF and №⑤

(although it is remote from urban districts, it is supposed to be leading a site by residents) is the highest point in OPLS.

Table 8 Evaluation result of proposed sites

Ranking	OPLS		CSDF	
	Proposed sites №	Points	Proposed sites №	Points
1	⑤	82. 6	①	87. 5
2	④	81. 1	⑤	87. 3
3	③	81. 0	④	84. 7
4	②	79. 2	③	83. 3
5	①	79. 1	②	78. 2

(5) Consideration of the result analysis

The features of evaluation of proposed sites for OPLS and CSDF in this case study are shown below.

- A proposed site №①(proximity to intermediate processing facilities) for each OPLS and CSDF are completely made on opposite evaluations.
- The distance of transportation and road maintenance (infrastructure maintenance) have a great influence on OPLS and CSDF.
- It is advantageous if there is a strong demand for a landfill from community residents.

The three things above can be considered shown below.

- ▸ For development of CSDF, it is expedient of practicing the land selection with consideration of the development of CSDF.
- ▸ Whether the land fill type is OPLS or CSDF, evaluation items and points should be considered with their features and properties of communities. These considerations lead to the land selection.
- ▸ Adopting these methods, hereafter, it is possible to select proposed sites which are able to develop at low costs for safer and higher reliance in CSDF. Also it leads to cost reduction from a synthetic perspective.

CONCLUSIONS

We suggested a method to choose the best pattern from ten development patterns at wide area. In the method of land selection of CSDF, we considered that setting condition based on feature of CSDF enables to construct reliable CSDF at low cost.

In future, it will be needed to repeat further analysis and case study for using these methods effectively.

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REFERENCES

The Landfill Systems and Technologies Research Association of Japan, NPO (1999) : Landfill Technologies Systems Handbook , pp67.

Japan Waste Management Association (2001) : A plan and The design point of The Landfill , pp 46-48.

Kokubo, H., Kotani, K., Katoh, T., et al. (2004)"A Study on Cost Reduction of Closed System Disposal Facilities", Modern Landfill Technology and Management, Proceedings of the 3rd Asian-Pacific Landfill Symposium in Kitakyushu 2004, pp.361-368.

The Landfill Systems and Technologies Research Association of Japan, NPO (2004) : Landfills in Japan (Revised Edition), The Journal of Waste Management.

Kokubo, H., Kotani, K., Katoh, T., et al. (2005)"A Study on Benefit and Cost Effectiveness of Closed System Disposal Facilities", Proceedings the 10th International Waste Management and Landfill Symposium in Sardinia 2005.