Administration Model for Urban Green Spaces in terms of Cool Island Effect

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Recently, participation of NPO in the management of the urban green spaces has been increasing rapidly. In these organizations (NPO), the operation and maintenance of urban green spaces including procurement of materials and employment of engineers has been managed by the fee from the residential community and the subsidy from the local government. This is a new concept of environmental management that the effect of the urban green spaces will be managed considering environment as "Resource" for generations and generations. There is little case where an environmental quality is examined as administrative resources. The purpose of this study is to propose and evaluate an environmental administration model of the urban green spaces which ha a good cool island effect and a harmonization between management method and cost and needs of the local community of the urban green spaces.

1. Background

The contingent evaluation method (CVM) and the travel cost method (TCM) have been proposed for the evaluation model of environmental policy. These methods evaluate not the residents' consented value but the environmental effect as an absolute value. The environmental value is evaluated as an absolute value to develop the environment policy and the urban planning. However, residents' agreeable amount is relative because of a peripheral environment, an social condition and a diversity of residents' sense of values. Therefore, that evaluation does not reflect willingness to pay of local residents. In the case of implementation of the construction and management project of the urban green spaces, it is necessary to propose the project valuation model including the plan, management, implementation and accountability of public project.

The objective of this study is to propose the environmental administration system based on a new concept of environmental management that the effect of the urban green spaces will be managed considering environment as "Resource" for generations and generations. In addition, the administration system of the urban green spaces that makes the cool island effect of urban green spaces function effectively and derive optimum feature of urban green spaces balancing construct and management cost of urban green spaces with needs of residents.

2. Outline of environmental administration system of the urban green spaces

2.1 The environmental administration system

The environmental administration system of this study is to evaluate necessity of environmental resources for residents, by comparing the amount of willingness to pay of local residents and the construction cost of urban green spaces under assuming that the residents defray construction and management cost of environmental resources. The application of the environmental administration system is shown as follows;

Application of administrative side
- Plan and management of construction project which corresponds to value of local residents' evaluation
- Accountability of construction project

Application of company side
- Basic information about purchase price and rent of

houses

The advantages of applying the environmental administration system are shown as follows;
1) Easiness of setting the rental fee for public institutions based on a consensus between residents and the government.
It is easy to understand the amount of the limitation of the payment, because the willingness to pay to environmental resources is described in a function.

2) Implementation of small government limitations
It is easy not only to construct the environmental resources that are necessary for residents but also to implement the government projects that are suitable for their budget scale, because administrative policy is made in terms of the balanced point of the demand for local inhabitants' environmental resources and the necessary construction cost of environmental resources.

3) Securing of project transparency and accountability
It is easy to understand the grounds of environmental policy selection, because the construction cost of environmental resources and the utility for residents are described in a function and used criterion for policymaking.

2.2 The outline of the environmental administration system of urban green spaces
Fig.1 shows the whole structure of the environmental administration system of urban green spaces.
The environmental administration system is composed by two functions of the environmental utility and the construction of urban green spaces. The utility function of urban green spaces is the environmental cost that residents feel the necessity to get some effects from green and pay to the urban green spaces. In general, the function of the urban green spaces is classified by their characteristics

and purpose. Takahara(1986) classifies the function of the urban green spaces into 5 kinds such as nature conservation, pollution protection, amenity and recreation. The willingness to pay is calculated in the each environmental function to examine the environmental administration system of the urban green spaces.
The construction cost include from construction to management of urban green spaces.
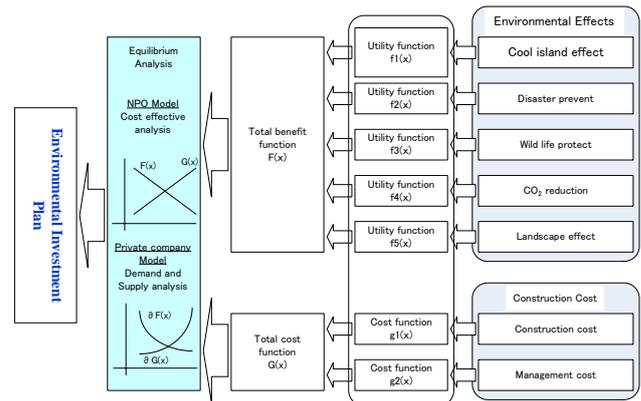

Fig. 1. The outline of the environmental administration system of urban green spaces

2.3 The Analysis model of the environmental administration system
The analysis model of the environmental administration system consists of NPO type and general corporate type in terms of the way of profit distribution and characteristic of the implementing organization.

1) NPO type
A relationship diagram of the income and expense from construction the urban green spaces are shown in Fig. 2.
In this case, the urban green spaces that are constructed in land cover ratio T0 bring the balance with the cost and benefit C0 yen. The balance point P between the income and expense becomes the turning point of operation approval in the case of NPO (without profit) If the management agency is a local government, this willingness to pay becomes the tax or a usage charge which propriety have to be
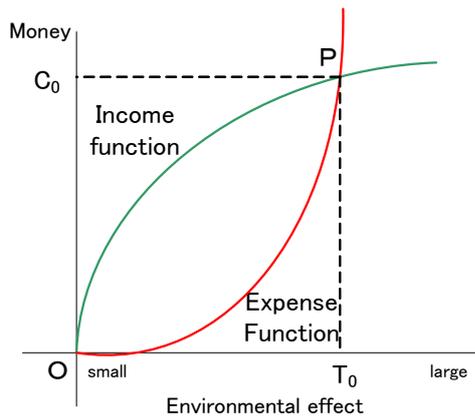
asked to the residents.

Fig. 2. The analysis model of the environmental administration system (NPO type)

2) General corporate type

Feasibility of the environmental administration that is implemented by a private company is examined based on introduction of concept of the market mechanism and the marginal analysis for the environmental administration of the urban green spaces bringing maximization of social benefits. The marginal cost and the willingness to pay show the supply curve and the demand curve of average local residents. Fig. 3 shows the supply and the demand relationship of constructing the urban green spaces.

Point Q that is the balanced point of the demand and the supply in Fig. 3 is combinations of land cover maximizing a social total surplus. At this time, rectangle QC_sOT_1 shows a total of the construction and management cost of the urban green spaces per annum. On the other hand, rectangle QC_dC_s shows a social total surplus from the construction of the urban green spaces. QC_dC_1 represents an effect that the local residents can obtain from constructing the urban green spaces decreasing temperature T_1 degree Celsius (Consumer's surplus). Triangle QC_sC_1 is the maximum value of the profit that the private company can obtain through collecting the C_1 yen from the local residents. When the private company manages the urban green spaces as environmental resources, the private company can

implement effective management by deriving area-specific demand and supply curve and selecting a construction project near the balanced point. If the organization without profit such as NPO implements management of environmental resources, the profit corresponding to triangle QC_sC_1 can be diverted to construction and management cost. And if the all profits divert to the cost and the interest rate is disregarded, the balanced point P of the income and expense in Fig. 2 become a possible point of the management.
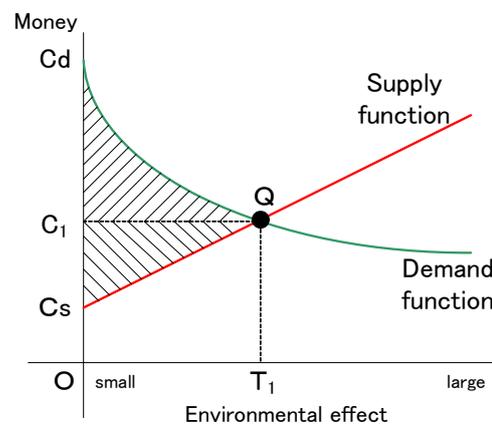

Fig. 3. The analysis model of the environmental administration system (General corporate type)

3. Analysis model of environmental administration model from viewpoint of the cool island effect

The resources in administration are 1) capital, 2) man power, and 3) physical resources. Environmental effects are produced from combination of these resources. The cool island effect of the urban green spaces produce utility from combination of the construction of urban green spaces (capital), the implementation and management (man power), and cool island effect (physical recourses), and the cool island effect can be manageable project. Here, the utility for the organization that construct the urban green spaces is income obtained as a tax or a use charge from local residents who enjoy the benefit of environmental

effect of the urban green spaces. The cost is the construction cost and management cost.

3.1 The creation of utility function in cool island effect

The utility function of the urban green space in terms of cool island effect is calculated by considering electricity bill produced from using air conditioner during summer season and regarding saving amount of electricity bill from temperature reduction by installation of the urban green space as WTP for the cool island effect of the urban green space. This value is reduction volume of living cost that the resident can obtain, and it is strictly different from the willingness to pay of residents. WTP for the cool island effect is estimated from the following 3 phases; a) Quantification of cool island effect, b) Calculation of air-conditioning charge per one family by applying the indoor heat transmission model, c) Calculation of WTP induced from the construction of the urban green spaces.

a) Quantification model of cool island effect

The utility function of the cool island effect is a function to estimate the amount of temperature depression based on the parameter defined from the area of land cover constituting the urban green spaces. Assuming that the air parcel over the urban green spaces is cooled only by the latent heat flux, the amount of temperature depression under the surface boundary layer is estimated (Fig. 4.). The effect of the sensible heat and the advection is not treated in this study.

b) Calculation of air-conditioning charge per one family by the indoor heat transmission model

The indoor heat transmission model which is shown in Fig. 5 is applied for calculation of saving amount of electricity bill resulting from establishment of the urban green spaces.
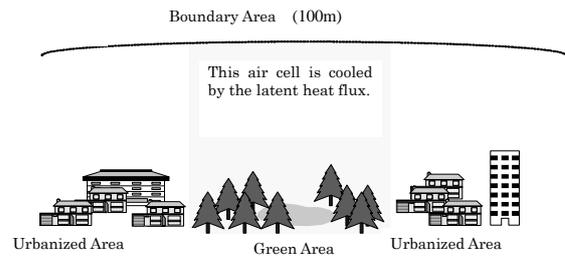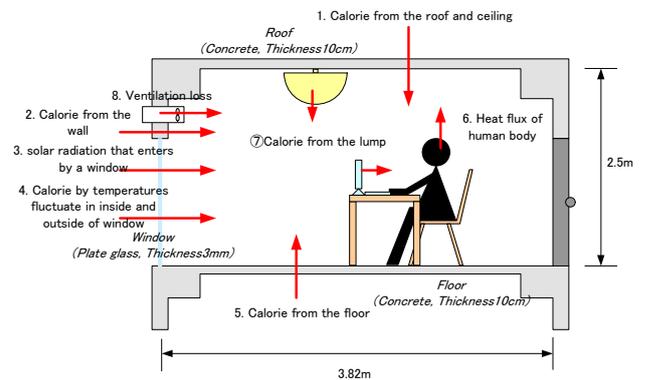

Fig.. 4. Concept of temperature decrease potential

Fig.. 5. The indoor heat transmission model

c) Calculation of WTP by constructing of the urban green spaces

The air-conditioning costs of the outside temperature with and without construction of the urban green spaces are calculated using the indoor heat transmission model. The amount of reduction for electricity bill is calculated from the difference of the expected values between the present temperature and the urban green spaces installed temperature based on the result of the energy conservation questionnaire.

3.2 Calculation of cost function of the cool island effect

The environmental cost of the urban green spaces is estimated by the sum of the construction cost and the management cost. The management cost was calculated from the management items to maintain the trees, grass land and water body (Table. 1.,2).

Table. 1. The unit of the planting works

Wood area			Grass area		
Item	Volume	Unit (per 100 trees)	Item	Volume	Unit (per 100m²)
Man power — Organizer	3.2	Person	Man power — Organizer	0.2	person
Man power — Engineer	16.1	Person	Man power — Engineer	1.1	person
Man power — Worker	9.6	Person	Man power — Worker	2.3	person
Direct cost — Camphor tree	100	trees	Direct cost — Grass	100	m²
			Soil	2.7	m³
Others	5%		Others	5%	

Table. 2. The unit price of the planting works

Item		Volume	Init
Cost of materials	Camphor tree	5000	trees/yen
	Grass	480	yen/m²
	Soil	1000	yen/3l
Laber cost	Organizer	21100	yen/day
	Engineer	16100	yen/day
	Worker	15700	yen/day

4. The environmental administration analysis for the protection of the cool island effect

4.1 Case study in the environmental administration system

The initial condition of the case study is assumed as follows;

a) The urban green space is constructed in the unused area covered by 20ha asphalt in the 1km² residential area.

b) The number of the local residents of this area is assumed to be 15000.

c) 15000 people obtain the various environmental effects due to the construction of the urban green space and are charged the necessary cost to manage environmental effect.

d) The environmental effect of the urban green spaces is including the cool island effect, the global warming controlling effect, and the effect of the landscape.

e) The redemption period in the urban green spaces is assumed to be 50 years, and redeems evenly every year.

4.2 The environmental administration analysis for the protection of the cool island effect

First, the construction cost for the each unit of the temperature reduction potential is calculated under the condition of the limitation of land cover As a result, the construction cost for the each unit of the temperature reduction potential is high on the following line l.

$$\ell : x_1 = 2x_2 = 0.8x_3$$
$$x_1 \geq 10,000$$
………………… (1)

Here, x_1 is glass land area(km²), x_2 is forest area(km²), and x3 is water surface area(km²).

Here, the reason why the combination of efficient land cover shown in equation (1) becomes a straight line in the (x1,x2,x3)-space is that the temperature reduction model in this report is linear. Fig. 6. shows the relationship between the temperature reduction potential and construction cost on the line l.
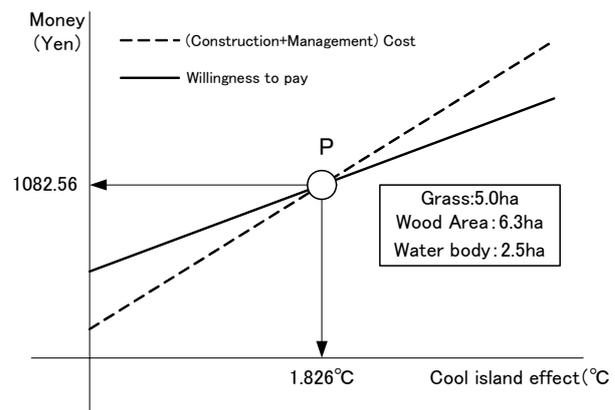

Fig. 6. The result of the environmental administration analysis (NPO Type)

In this case study, according to the administration analysis of the balanced point between the total construction and management cost per a person and the total willingness to pay of residents per a person, as shown in Fig. 8, the balanced point P composed of the glass area of 5ha, the water surface of 2.5ha and the trees area of 6.3ha has potential of temperature reduction of 1.83 degree Celsius and the income from the management of the urban green spaces is estimated to be about 16 million, therefore, the point P is proved as the possible limits of environmental administration for NPO.

Therefore, the urban green spaces administration plan which is brought closer to the point P is essential for the NPO administration. Next, we are going to examine about the possibility of environmental administration system by the private company. Figure 7 shows the relationship between the temperature reduction potential and the demand-supply curves in the construction of the urban green spaces.
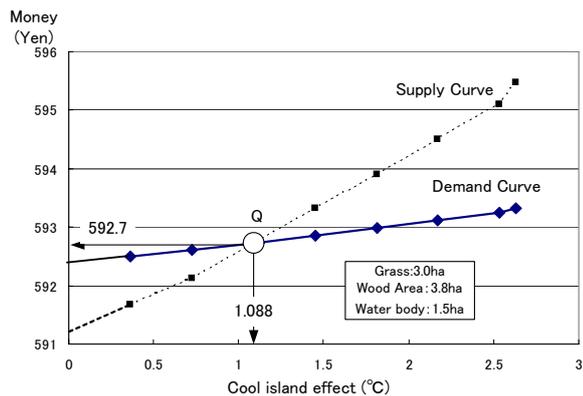

Fig. 7. The result of the environmental administration analysis (General corporate type)

If the construction of the urban green spaces is conducted under the balanced point Q which has the land cover composition of grass area of 3.0ha, woods area of 3.8ha and water body of 1.5ha, the air temperature reduction potential is estimated to be 1.09 degree. In this case, the construction and management cost in terms of the cool island effect protection is estimated to be 8.9 million yen. The profit of the private company managing the urban green spaces shown in the CQB area in figure 9 is estimated to be 9311 yen per a year. Demand and supply functions shown in figure 9 are the functions of the air temperature reduction potential in the optional thermal condition.

In the future, high accuracy balance analysis using the function considering the supply cost increase and the decreasing the demand (willingness to pay) is essential for lower thermal condition. In this study, we develop the environmental administration system in the urban green spaces in terms of the cool island effect derived from the urban green spaces by comparing the benefit obtained from the cool island effect and the cost calculated from the construction and management of the urban green spaces. When assuming that three environmental effects are selected from the public function of the urban green spaces and the construction cost is fairly distributed among stakeholders, possibility of existence of the balanced point between the construction cost and the income and of the environmental administration system from the construction to the management are approved in the case study. At present, this environmental administration system has the problems to be solved such as the accuracy of the system and the adaptability to the field. This system is expected that not only the policy making supporting tool from the construction to the management of the urban green spaces but also the function as accountability to the local residents.

5. The challenges for achievement of the environmental administration system

The improvement to generalize the environmental administration system is obtained by reconsidering the evaluation model of quantification and forecast of cool island effect and environmental economy. The challenges for the accuracy improvement of the management system are shown as follows.
(1) Reconsidering of utility function in the cool island effect
(2) Accuracy improvement of cool island function
(3) Accuracy improvement of cost function of construction and management of the urban green spaces
(4) Necessity of construction of the comprehensive environmental administration system of the urban green spaces including the other environmental effect such as the ecosystem protection effect and the disaster prevention effect.

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