Sustainability Governance for Planning of River Environment

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ABSTRACT In sustainable infrastructure planning such as transport and river improvement we should consider needs and requirements from the planning district or site. These opinions of each stakeholder are essentially multifarious and different. So, we should prepare the stage on which the decision-making is promoted smoothly. Here, the objective of this study is to define the sustainability governance as an effective stage of the river environment planning, to propose a trial balloon and to examine a practical model for the specified process of planning in view of sustainability. SEA is defined as a process of ensure that significant environmental effects arising from policies, plans and programs are identified, assessed, mitigated, communicated to decision-makers, monitored and that opportunities for public involvement are provided. It has become an important instrument to help to achieve sustainable development in public planning and policy making. Several techniques are combined at three stages. We introduce three sectors, namely, the planning administration, the community and adjusting members of them to make the process of decision-making. The opinions and information can be exchanged among these three sectors in terms of dialogue system. Workshops are generally available for constructing the interrelationship among such sectors. Moreover, we introduce some methods on systems analysis such as morphological modeling, structural modeling and comprehensive evaluation modeling in the process of decision making and the workshops dynamically. Through this new planning process, we concluded the following points: 1) the comprehensive planning system in view of sustainability governance was possible to be effectively applied to the decision-making on the river environment, 2) the important contents and factors were founded due to the discussions on the workshops, 3) the alternative plans were selected and are assessed by the governance, and 4) the governance was extended into non-political organization (NPO) which made a important role of the planning.

1. INTRODUCTION

In Japan, since the new river law was established, it has been necessary to introduce the synthetic planning including river environment in addition to flood control and water use in the river improvement project. Planning system which reflects the opinions in the watershed should be also added into the tasks of river environment improvement and its conservation. That is, the improvement plan should be promoted in response to needs for regional inhabitants. In these years various discussions have been developed on building the methodology. The most important thing is to complete the decision process of planning and to introduce public participation into the process. In our past researches, some results were obtained for the establishment of such planning process. However, the more advanced and strategic planning process is still needed. It is essential to construct a governance with various stakeholders discussing and adjusting their ideas. The governance is defined here as the platform dealing with the processes and systems by which a set of stakeholders or society operate. On the other hand, the government is established to administer these processes and systems.

The objective of this study is to introduce sustainability governance, to establish selection of the alternative plans and to build a procedure for determining the most appropriate river improvement plan on the platform of sustainability governance.

2. SUSTAINANILITY GOVERNANCE FOR PLANNING

2.1 Basic Concept of Sustainability Governance

Sustainability governance is capabilities and mechanisms to be acquired by the entire society, including central and local governments, companies, universities and even individual citizens, to solve problems pertaining to sustainability. In 1987, the Bruntland Report, “Our Common Future”, defined sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainability is based on the concept arising from the report. Namely, it is an attempt to provide the best outcomes for the human and natural environments both now and into the indefinite future. It relates to the continuity of economic, social, institutional and environmental aspects of human society, as well as the non-human environment. Sustainability affects every level of organization, from the local neighborhood to the entire planet [from Wikipedia]. So sustainability governance can be considered as the whole stage for every level of organization and every level of stakeholder.

2.2 Method of Strategic Environmental Assessment

In Japan the river environmental improvement is executed by national or local government based on the synthetic plan of a river basin. More advanced plan they have, more dependent on the execution the community is. As a result, the conflict often appears between them. Therefore, it is necessary to make a communication system for acquisition of common information with each other. This system is a kind of risk communication. We defined a workshop as a supporting group of communication.

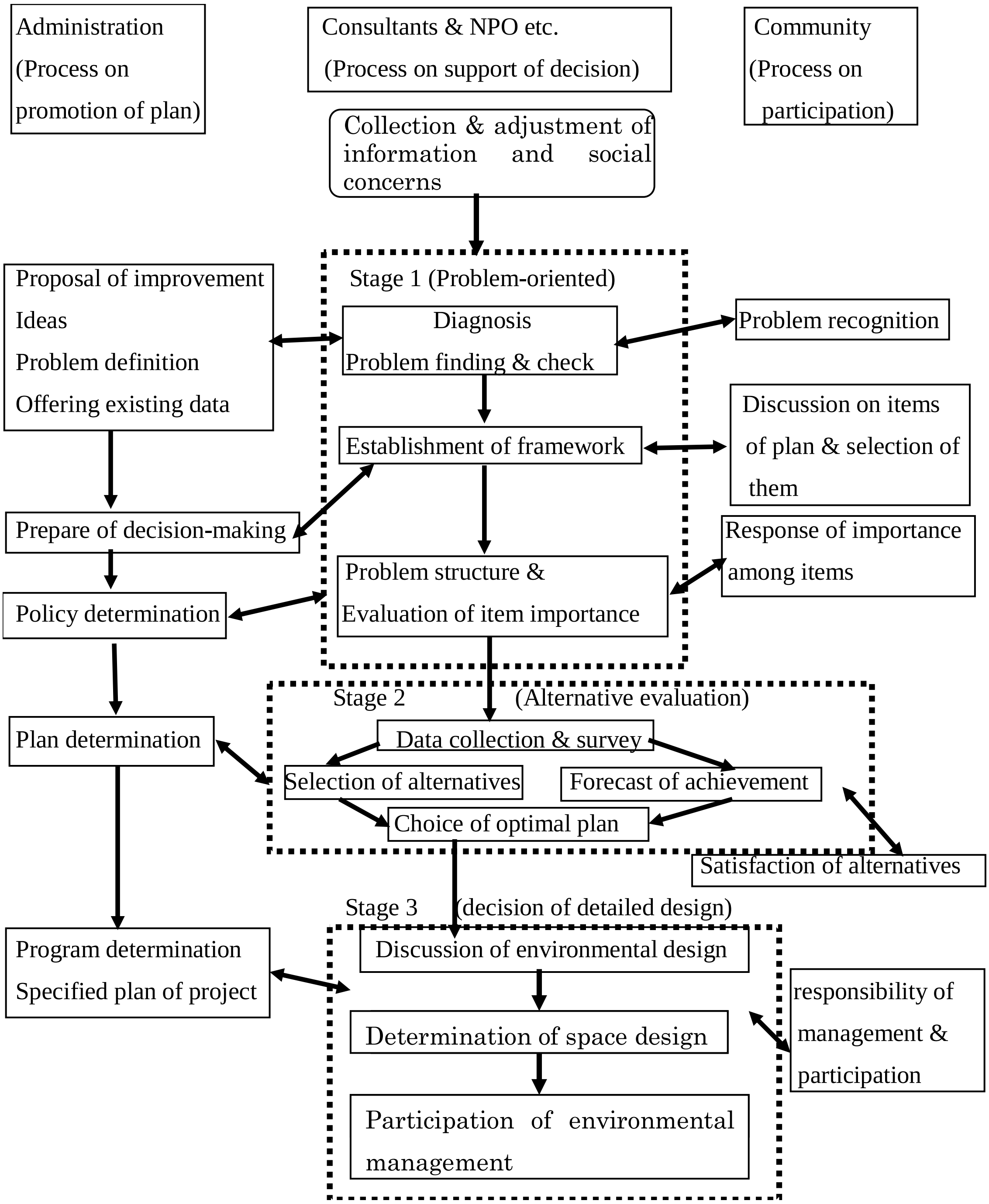


Figure 2.1 Process of plan making in view of SEA

Here a procedure of process of making a plan was developed due to the concept of strategic environmental assessment (SEA). SEA is the formalized, systematic and comprehensive process of evaluating the environmental effects of a policy, plan or program and its alternatives, including the preparation of a written report on the findings of that evaluation, and using the findings in publicly accountable decision-making [1]. In this study we made three phases of procedure from stage 1 to stage 3 as shown in Figure 2.1.

Stage 1: First of all, problems finding and checking are discussed in terms of brain-storming and morphological method. Next, structural models are constructed due to fuzzy structural modeling. The models are used for the policy-making of river environmental project.

Stage 2: In this stage the plan-making of the project is promoted mainly. Actually, several alternative plans are selected through discussions for achieving the aims. Afterwards, the most appropriate plan is determined in terms of fuzzy multi-criteria analysis. And then, the benefit is estimated by CVM in order to confirm the validity of analysis economically.

Stage 3: The outline of design is discussed from view of some basic factors related to the river environment. Several designs with some attribute are evaluated in view of some attribute and several levels with them. Conjoint analysis is used for the evaluation. Next, the concrete design is drawn due to the platform of the governance. The governance is composed of some stakeholders. The workshop is prepared for the discussion in the platform of the governance. Namely, the workshop is built in order to coordinate with each stakeholder. As stakeholders are composed of the administrative organization, the inhabitants and some experts belonging to the literates, consultants, NPO etc., the participants of workshop belong to them. The role of the workshop is important to prepare some basic information as follows:

1) Determination of overall framework: Based on the motivation proposed by the government, they discuss the overall framework of project and devise the factors with relevant to the project. It is indispensable to understand the policy and to begin the project.

2) Determination of the evaluated alternatives: Based on the plan of the overall project, they select several factors and comprise several alternatives using such factors. It is necessary to build the appropriate plan.

3) Determination and confirmation of the optimal alternative: Based on the result of inhabitants' awareness and the discussion of workshop members, they discuss and confirm the optimal alternative plan of river environmental improvement. Moreover, the workshop discusses the detailed design of the environment in the river basin. Through the adjustments of the different opinions, the reasonable design is determined finally.

Concretely, the inhabitant interests are surveyed as the information of the river improvement project. The necessity of river improvement project is found.. And then, the effective factors which contribute to understanding of inhabitants are introduced. Moreover, the final aim is to build the decision-making system on the plan for the river environmental which the inhabitants desired.

3. SUPPORTING ALGORITHM OF THE STUDY

3.1 Method of grouped fuzzy structural modeling

In fuzzy structural modeling (FSM), the difference of importance between each item is indicated in continuous space of [0,1]. The algorithm of FSM is composed of estimating the direct and indirect relationship due to fuzzy extensive principle and drawing the results using graph theory. Here, the method was proposed to estimate the difference of importance in each item and to adjust the values developed by Zarhariev et al [2]. First of all, let us explain the algorithm of determining the preferential structure using fuzzy contributive rule. Let two preferential contents be a_i and a_j. We define the preference of a group by the following equation by using the contributory function $\tilde{C}^k$. This function represents the degree of contribution to the group preference.

$$a_i R a_j \text{ iff } \tilde{C}_m^k(a_i, a_j) > 0 \tag{1}$$

$$\tilde{C}_m^k(a_i, a_j) = \tilde{u}_k(a_i) - \tilde{u}_k(a_j) \tag{2}$$

where a relation $a_i R a_j$ means a_i is superior to or equals a_j for the decision maker k and is satisfied with connective and transitive conditions. The contributory function $\tilde{C}_m^k(a_i, a_j)$ is the degree of preference of the decision maker k in case of a_i against a_j. $\sim$ represents fuzzy number. The difference of importance in whole group is defined as minimum distance among each relationship as equation (3).

$$R^M = \min \sum_{k=1}^{q} d(R, R_k) \tag{3}$$

where $R_1, R_2, ..., R_k, ..., R_q$ are fuzzy preference relations that express the decision-maker's estimations and let us assume that

$$\mu_{R1}(a_i, a_j) \le \mu_{R2}(a_i, a_j) \le .... \le \mu_{Rq}(a_i, a_j) \tag{4}$$

We can determine the fuzzy relation R^M as the group including member 1 to member k using the median among the group like the following equation:

$$\mu_R^M\left(a_i,a_j\right)=\mu_R^k(a_i,a_j),$$

where $k=(1/2)(q+1)$, if q is odd, (5)

$$\mu_R^M\left(a_i,a_j\right)=(\mu_R^k(a_i,a_j)+\mu_R^{k+1}(a_i,a_j)),$$

where $k=(1/2)$ if q is even. (6)

Thus fuzzy relation that is the nearest in the sense of Hamming distance to given fuzzy preferential relations is determined by equation (4) to equation (6). The obtained variable $\mu_R^M\left(a_i,a_j\right)$ is a median in total preferential relation and is defined as the minimum distance of every difference between preferential relations. The matrix is composed of the total items m by each obtained relation. Then, the direct or indirect influences are computed due to the Cartesian product of the matrix. Finally the relational graph is indicated.

3.2 Fuzzy Integral as a Multi-Criteria Analysis - Choquet Integral.

Fuzzy evaluation is based on the fuzzy integral using the degree of importance indicated by fuzzy measure [2]. Yager developed the theoretical evaluation method combined multi-criteria [3] analysis with the fuzzy evaluation. In the fuzzy multi-criteria analysis, we should obtain both achievement of the evaluation criteria and their importance basically. Here, we introduce Choquet integral as a kind of fuzzy integral. In the case of applying multi-criteria to planning like river improvement project, the data are often ambiguity. So we should consider such characteristics. Choquet integral is generally formulated as shown in equation (7).

$$(c)\int h(x)dg=\int_0^\infty g(x/h(x)\geq\alpha)d\alpha \quad (7)$$

Equation (1) represents the integral with the function $h:x\to[0,\infty]$.

When function h is represented as

$$h(x)=\sum_{i=1}^{n}(\alpha_i-\alpha_{i-1})\chi_{xi}(x) \quad (8)$$

where $h:x\to[0,\infty]$, χ_{xi} is defined function of set X_i,

Choquet integral is redefined as:

$$(c)\int h(x)dg=\sum_{i=1}^{n}(\alpha_i-\alpha_{i-1})g(X_i) \quad (9).$$

Where α_i; achievement of each attribute, $g(X_i)$; a set of importance, and

$$0\leq\alpha_1\leq\alpha_2\leq\ldots\leq\alpha_n,\alpha_0=0 \quad X_1\supset X_2\supset\ldots\supset X_n \quad (10),.$$

3.3 Contingent Valuation Method (CVM)

3.3.1 Environmental Value

The value of environmental quality is divided into use value and nonuse value. (Sometimes we consider positive use value as use value and passive use value as nonuse value). The use value is the value which is indicated by resource utilization and spatial utilization of the environment. Moreover the use value can be classified into direct use value and indirect use value. The direct use value is the value which is brought in case of consumption of resource from environment. The indirect utility value receives the service from environment. Meanwhile the nonuse value does not relate to the value mentioned above. Typical one is existence value. The existence value does not connect with utilization at present or in the future both directly and indirectly. But it is given by individual preference such that the environment would not be lost. It is called a peculiar value. In addition, there are bequest value and option value that have both properties of use value and nonuse value. The bequest value is a value for leaving environment and resources for the future generation. It is also the value which is related to future utilization.

3.3.2 Evaluation in terms of CVM

When there is originally no market on the evaluation, CVM makes a market imaginarily and intends to consider it.

In this method, first of all, the contents of environment and administrative service are introduced to the respondents. And then, willingness to pay is asked toward heightening the level of environment. On the other hand, we can consider willingness to accept compensation if environment or administrative service is declined. WTA is indicated as the necessary money to obtain the original utility again. CVM can also evaluate both the use values and holdover value. Direct and indirect use value and option value are measurable even in terms of usual consumer's surplus analysis and Hedonic approach which is a kind of the analyses on the non-market material. But it is only possible to evaluate the existing value in terms of CVM. The CVM is possible to estimate not only the values of substantial environment or administrative service but also their virtual values. On the basis of the questionnaire supposed to the imaginary situation, it is possible to ask monetary values of environment and the administration service directly. The questionnaire of WTP in CVM is divided roughly into the following four methods.

1) Method due to free answer: to ask sum of payment freely.

2) Method due to bid price using game mode: to ask agree or disagree with the proposed price to repeat until obtaining the answer of No.
3) Method due to payment card system : to answer the appropriate value within some alternative choices.
4) Method due to a pairing choice system: to ask agree or disagree with proposed price
This study adopted the payment card system.
(3)Estimate Model of WTP

Suppose the probability of agreement with a given WTP price to $\Pr[yes]$, it is formulated as Equation.(5).

$$\Pr[yes] = \frac{1}{1+e^{-\Delta V}} \qquad (11)$$

where ΔV ; a difference of utility between proposed prices.
Here, supposed that Equation (11) is transformed into Equation 12), it can be estimated parameters of estimate equation by means of maximum likelihood method [4].

$$\Delta V = \alpha + \beta T + \sum_{i=1}^{n} \gamma_i y_i + \sum_{k=1}^{m} \delta_k z_k \qquad (12)$$

where $\alpha, \beta, \gamma, \delta$; parameters, T is a proposed price, y_i ; variables of a respondent's attributes ($i = 1, n$), and z ; variables of a respondent's awareness ($k = 1, m$).

3.4 Conjoint Analysis as Supporting Approach of Workshop

The alternatives handled in this study are combined of the multiple river improvement measures. Each service level has also been considered from various categories. The conjoint analysis is applied to planning fields, environment economics, etc. in these years [5]. The analysis procedure is summarized as following aspects briefly:
1) Evaluated Attributes: Several attributes are introduced to determine the value of plans. Each attribute is consisted of several levels. The alternatives are combined of the multiple river improvement measures to increase environmental level of river basin. Each attribute is evaluated due to utility value of some respondents. The evaluated levels of each attribute are considered as various categories.
2) Comprise Profiles: The card called a profile is prepared and used. The profile is a lattice of the factors composed of a series of attributes. This is specific plans consisted of multifactor. Each attribute value (partial utility value) is evaluated by showing this profile to the respondent, and asking the whole utility of the profile,.
3) Analyze the Obtained Data:
Equation (13) represents an estimate of the whole utility.

$$\hat{r}_i = \hat{\beta}_0 + \sum_{j=1}^{p} \hat{u}_j (k_{ji}) \qquad (i = 1,2,.....,n) \qquad (13)$$

where $\hat{u}_j(k_{ji})$; an estimate of the partial utility of the level k_{ji} in the attribute j in the profile i. $\hat{\beta}_0$; an estimate of the constant parameter β_0, and $\hat{\gamma}_i$; an estimate of the evaluation γ_i for the evaluation object (profile), and n ; a total number of the profiles, and p ; a total number of the attributes.
Moreover, importance score of attribute j for indicating the relative importance of each factor is shown in Equation (13). Here, RANGE is a difference between maximum and minimum of utility value of attribute j in Equation (14) and Equation (15).

$$IMP_j = 100 \frac{RANGE_j}{\sum_{j=1}^{p} RANGE} \qquad (14)$$

$$RANGE_j = \text{maximum of } \hat{u}_j(k_{ji}) - \text{minimum of } \hat{u}_j(k_{ji}) \qquad (15)$$

The remarkable advantage of Conjoint Analysis is to estimate how the value changes, when it rearranged the value element of alternative plan, and when it added the new value element in it. Namely, it is not only to clarify in which part there is a problem on the whole plans but also to estimate the variation when it measures the value by the decomposition of the whole plans at the moment. Some river improvement plans are considered as the alternatives in the river basin. Based on the approach, the preference measure of the citizen was surveyed in terms of the conjoint analysis. The profiles with whole concepts are presented to the examinee.

4. EMPIRICAL RESULTS

4.1 Existing Condition of Study Area

In order to introduce these approaches, we selected the Aioi-Nakajima District in the middle stream of the Tokachi River as shown in Figure 4.1

The capacity of the river discharged flow in the district is insufficient on present state. That is, the flow of the river is prevented in affects of the heavy rainfall, etc. in this district. As a result, the affect reaches to the upstream seriously. The outline of the district is represented in the following contents.

Table 4.1 Outline of questionnaire surveys to the inhabitants and to the workshop

Age (%)	20-29 7(8)	30-39 20(13)	40-49 22(46)	50-59 28(23)	More than 60 24(8)
Distance between dwelling and district (%)	Less than 4km 8	4km-5.9km 17	6km-7.9km 28	8km-9.9km 23	More than 10km 25
Consequence of flood control (%)	Very important 41	Important 47	Fairly important 7	No important 5	
Consequence of natural environment (%)	Very important 52	Important 38	Fairly important 7	No important 3	

Notes: only number represents ratio of inhabitants and (number) shows ratio of workshop members

1) The part of the Tokachi River around the Aioi-Nakajima district has 7,100m^3/sec as the planning flood flow. But now it secures only 3,200m^3/sec as the existing safe flow.

2)Aioi-Nakajima District is composed of a large sandbank. it is not possible that the flow run smoothly because of high land level. Therefore in the upstream, water level increase rapidly when the flooding occurs. It has a fear of a large damage in the urban district caused by flowing over the levees.

3) In Aioi-Nakajima District there is no damage in life and property directly, because the inhabitant does not live there when flooding occurs. However, it becomes necessary to execute the river improvement for prevention of overflows and reduction of the damage from flooding. At the same time, many trees such as the willow flourish in the river would become obstacles to the flooding flow. Moreover a large meander of the river would not hinder flowing smoothly to the downstream.

4)On the other hand, it is important to reserve the forest of a special kind of willow and rich nature such as the nesting place of the rare swallow, nevertheless urban suburban area existing in Obihiro City, Otofuke town,and Makubetsu town.

First of all, the questionnaire survey was executed to grasp the fundamental ideas from the inhabitants and the workshop members. The ratio for attribute of both residents and workshop members are shown in Table 4.1. In this survey, the respondents were selected from almost every generation and every occupation equally. Most of them have much consequence for both flood control and conservation of natural environment. On the other hand, the participants in workshop are from various occupancies, but in the generation of forties [6].

4.2 Preferential structure models of river basin problems

At the first stage, the method of brain storming was introduced in order to some ideas on the general river sustainable improvement freely.

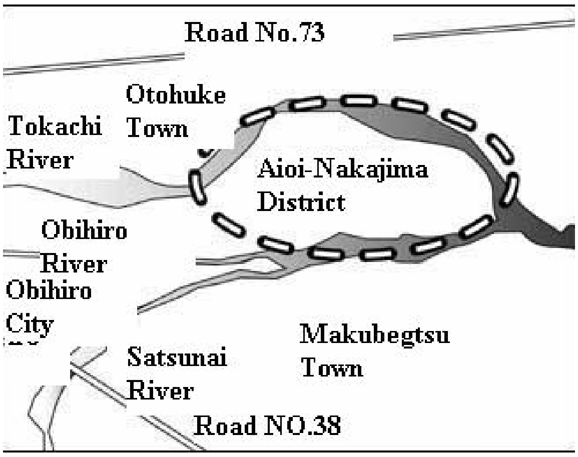


Figure 4.1 Map of Aioi-Nakajima District

Afterward, the obtained ideas were arranged by KJ method, one of morphological methods. As a result, the ideas were put together into the following 6 items: i) prevention of the flood damage (flood control), ii) access to the river site, iii) sufficiency of communing the nature of river, iv) substantiality of the land use in the district, v)maintenance of the natural environment, vi)protection of flora and fauna.

Next the importance among the items was hierarchically evaluated by the fuzzy structural modeling (FSM) technique compared with residents and workshop members.

Table 4.2 Result of FSM analysis

respondent	Preference structure by degree of importance
residents	A>E=F>B=C=D
workshop members	A>E>F>B=C=D

Notes symbol >:superior, symbol= indifference

legend: A: flood control, B: access to the river site, C: communing the river nature, D: land use in the river, E: maintenance of natural environment, F: protection of flora and fauna

On basis of the proposal of discussion and the adjustment of ideas due to KJ method, we analyzed the hierarchical structure for improvement items of the concept.

Table 4.2 shows the result obtained from the survey for residents and workshop members. This shows the flood damage prevention is the most important in both cases. The approach of natural environmental conservation and flora and fauna protection are ranked at the next stage. It is similar to the results both respondents. Namely, both groups think that the basic items river improvement planning are significant. The items of the familiarity with river, the access to riverside and the improvement of land use in the river are ranked at the bottom.

That is to say, large difference is not seen between residents and workshop members.

4.3 Evaluation of Alternatives in Workshops

4.3.1 Discussion of alternatives in workshop

In the Aioi-Nakajima district, workshops for planning river improvement have been opened since the beginning of 2002. By the discussion in the workshop, the alternatives were obtained mainly as excavation of the new waterway, excavation of the intermediate water channel, widening of the existing waterway, etc.

It is shown in Table 4.3.

4.3.2 Decision of the whole alternative project

The basic ideas on river improvement plan of residents and workshop participants were grasped by discussion in workshop and support planning system. Alternative projects should be evaluated relatively. Here, the alternative projects were mainly composed of five plans. The evaluation items(factors) were selected such as i) prevention of flood damage, ii)access to the riverbed, iii)substantiality of the communing with the river, iv)substantiality of the land use in the district, and v)maintenance of the natural environment. Table 4.4 demonstrates these evaluation items are evaluated in the continuous interval from 0 to 1. The larger the numerical value is, the higher the expectation is. The degree of importance was also shown in Table 4.4.

The comprehensive evaluation was executed by using Choquet Integral. The results also represent in Table 4.4.

Alternative 2 was optimum plan as a result of analysis. That is, the mid-scale riverbed excavation

should be chosen as the optimal project. On basis of the result, the evaluation by inhabitant around the study area is carried out. Another analysis mentioned that it became 1.5 billion yen for improvement cost of the optimum plan by estimate.

Table 4.3 Alternative discussed in the workshop

Alternative plan	Contents	Demerit and merit
1.Excavation of new waterway with straight line	/Excavation with straight line /Modification of waterway width	/Impossible access to sandbank /Risk of stoppage /Risk of destruction of bird nests
2. Excavation of mid-scale riverbed in existing waterway	/Excavation intermediately with straight line /Construction of some ponds within river	/Use intermediate bed only on flooding time /Use ponds for application of flood control and water use /Possible access to sandbank
3. Expansion of existing waterway	/Expansion of existing waterway /Construction of floodwater storage area	/Deforestation /Risk of erosion in riverside /Use ponds for application of flood control and water use
4. Expansion of existing waterway and up-stream improvement	/Expansion of existing waterway /Construction of stored floodwater area /Change of waterway in upstream	/Large-scaled deforestation /Risk of erosion in riverside /Use ponds for application of flood control and water use
5.Excavation of new low-head waterway	/Excavation of new shallow waterway /water flows along waterways at usual time	/Risk of stoppage due to sedimentation /Large cost of maintenance

Table 4.4 Evaluation of alternative projects due to Choquet integral

1) Important weight due to fuzzy measure

$\alpha_1 = 0.25$	$\alpha_1 = 0.20$	$\alpha_1 = 0.16$	$\alpha_1 = 0.13$	$\alpha_1 = 0.35$

2) Achievement degree of each item

Alternative project	Factor1	Factor2	Factor3	Factor4	Factor5
1.new channel excavation	0.8	0.1	0.5	0.1	0.5
2.mid-scale riverbed excavation	0.9	0.8	0.8	0.5	0.6
3.channel expansion	0.3	0.5	0.8	0.8	0.1
4.upstream control & channel expansion	0.3	0.5	0.8	0.7	0.1
5.new low-head channel excavation	0.7	0.3	0.6	0.5	0.3

3) Results of comprehensive evaluation

Alternative project	1	2	3	4	5
Evaluation value (order)	18.03 (3)	29.52 (1)	17.01 (4)	16.51 (5)	18.93 (2)

4.4 Analysis due to CVM

4.4.1 Outline of survey for CVM

As mentioned in the previous section, we discussed the appropriate basic river improvement plan in workshops. As a result, we could find the optimal plan for workshops. Based on such a plan, it was examined if it would be accepted by inhabitants. The following suppositions were provided for inhabitants.

1) River improvement would be promoted as a new waterway in the sandbank, which has 400 meters width and 2 meters depth.

2) A part of the budget would be provided by expense of the area in river basin for twenty years.

In this condition, we asked how much they would pay for promoting this project. On the survey, we adopted the paid card which is selected by inhabitants and all concept method for profile. The obtained WTP is regarded as the necessity of the project. We also built the Logit model based on random utility theory as the estimate model. By using this model, we can argue the inhabitant's consequences for river improvement with relevant to their attributes and awareness. In this way, the opposed answers towards expenses paid by tax were excluded. Figure 4.2 demonstrates the distribution of respondents' WTP. The simple average WTP is provided for 2,516 yen.

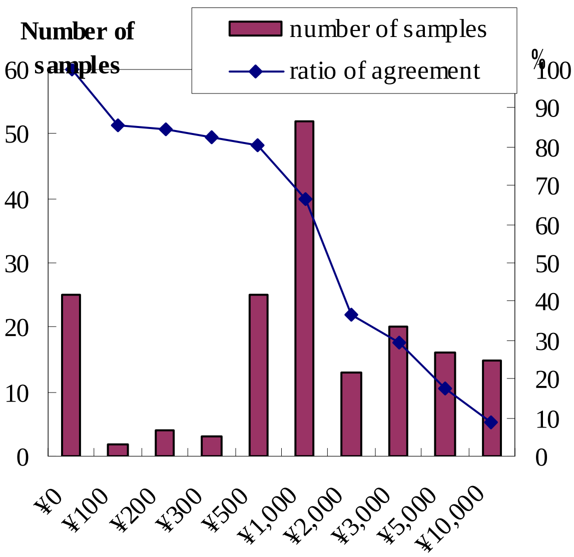


Figure 4.2 Results of calculation due to CVM questionnaire

Table 4.5 parameter in the model due to CVM

contents	unit	parameter	T value	judgment	mean
Proposed sum β	**yen**	**-0.0007**	**-17**	***	**-**
Annual income γ	**1 to 5**	**0.1727**	**2.253**	**	**2.302**
Constant α	**-**	**2.3077**	**6.536**	***	**-**
Concern to flood control	**1 to 7**	**-0.8469**	**-9.305**	***	**1.711**
Age generation	**1 to 5**	**0.1857**	**3.169**	***	**3.459**
Likelihood ratio	**0.481**				
Hit rate (%)	**84.64**				

** 5% and *** 1% significance

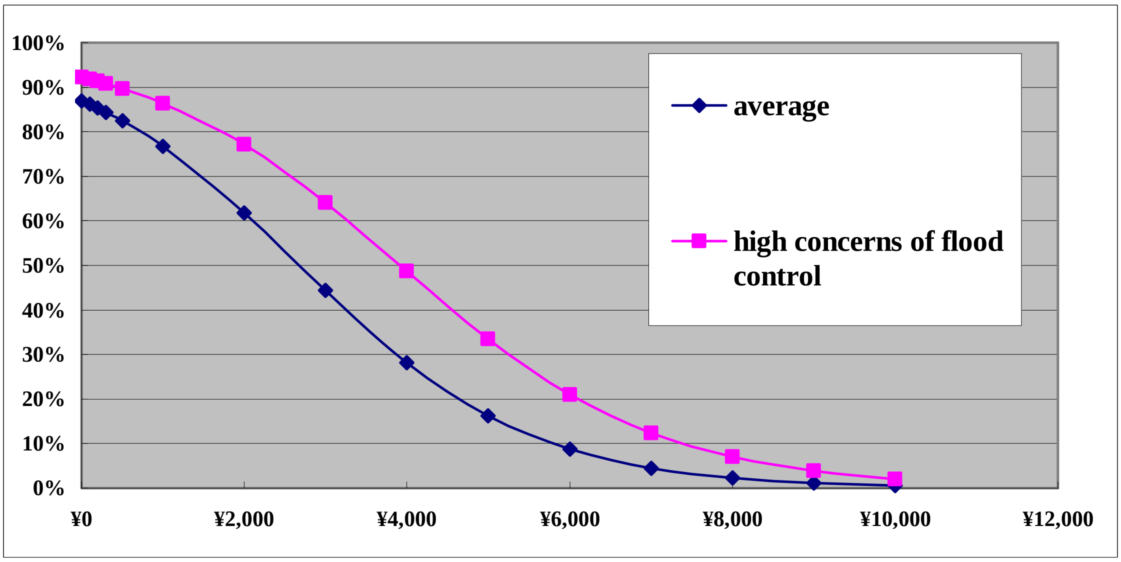


Figure 4.3 Differences of WTP between the segments of concerns of flood control

The model discussed in section 3.3 was estimated by using maximum likelihood method. The model discussed in section 3.3 was estimated by using maximum likelihood method. The result is represented in Table 4.5. In this model the proposed WTP, annual income, consciousness of flood control contributed to the model strongly. In particular, the consciousness of flood control influenced to the estimated WTP largely. In this case, smaller the discrete number represented the category of flood is, the higher the concern for flood control is. Figure 4.3 demonstrates WTP values in the different segments, that is, high-concerning group and all the respondents. The difference between two groups is 1,235 yen as median. Inhabitants who have the high-grade concerns for flood control also value high WTP. At the same time such inhabitants have the experience of voluntary activity and flood drill activity simultaneously.

Table 4.6 Total amount of willingness to Pay (WTP)

Annual WTP per household	2,682 yen
Accumulated WTP in twenty years per household	37,900 yen
Annual total WTP of residents in the district	279 million yen
Accumulated WTP in twenty years of residents in the district	3,944million yen

Finally, WTP was estimated for total amount in the whole municipality. Table 4.6 shows the total amount of WTP. WTP per household is 2,682 yen in a year, and 37,900 yen for twenty years. The total amount of WTP in the region is 279 million yen in a year, and 3,944 million yen for twenty years. In this connection, the total cost is counted for 1,500 million yen to complete the river improvement project. Therefore, the inhabitants require for the project, because the total WTP exceed the total cost in the long term plan.

4.4 Evaluated Results of Alternatives by Conjoint Analysis

4.4.1 Outline of Questionnaire

As mentioned above, it is necessary for inhabitants to promote river environmental improvement. Here, the specific alternatives were assumed in terms of several attributes. Table 4.7 represents four attributes and their levels of category. Using these attributes and their levels, we proposed eight alternatives combined with them to the respondents. The alternative which the inhabitants desired was grasped in terms of this analysis. In this survey, the alternatives visualized were adopted to be understood more easily.

Table 4.7Attributes and their levels of Conjoint Analysis

Attribute (factor)	Level 1	Level 2
A. forests along riverside	Nature friendly method	Conventional method
B. trees in a waterway	Nature friendly method	Conventional method
C. ponds in waterway	Nature friendly method	Conventional method
D. roads along riverside	Nature friendly method	Conventional method

4.4.2 Analysis of Results by Questionnaire

Figure 4.4 shows the partial utility of each attribute. In all attributes, the inhabitants evaluated utilities for method of nature friendly. Considering the importance of each attribute, trees in a waterway (B) and roads along riverside (D) is evaluated for higher concerns. At the same time, the utility of Nature friendly method is higher in

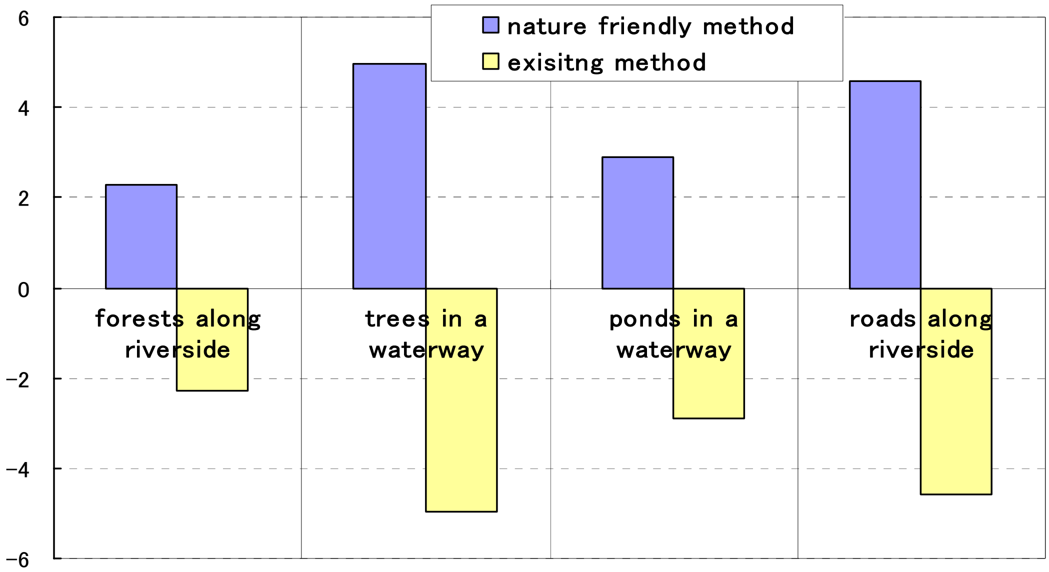


Figure 4.4 Partial utility of each attribute

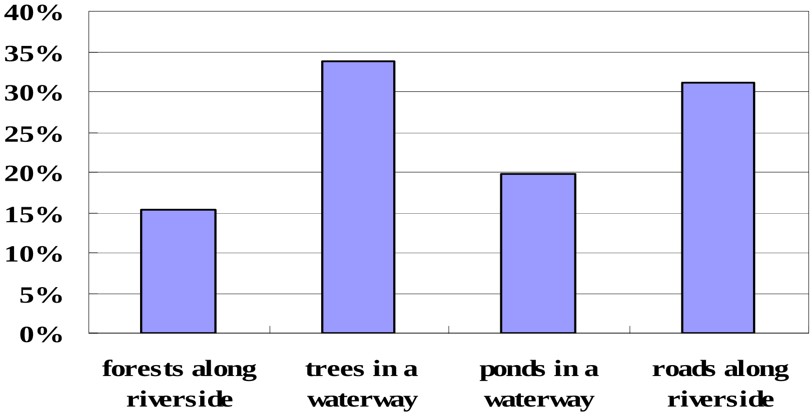
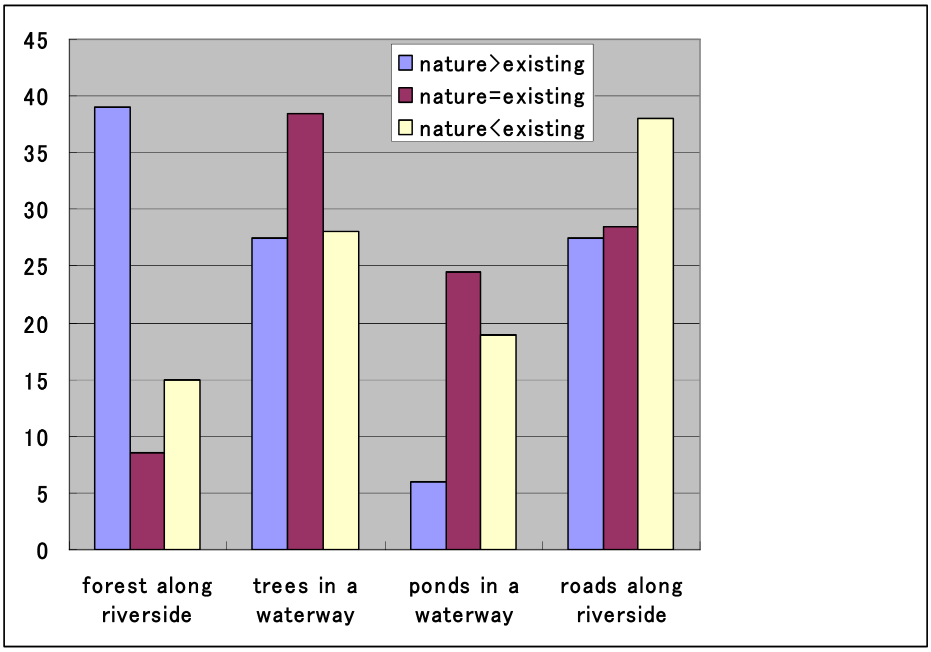


Figure 4.5 Importance of each attribute



nature>existing: the concern of nature friendly method is larger than that of existing method
nature=existing: both concerns are almost same.
nature<existing: the concern of nature friendly method is smaller than that of existing method.

Figure 4.6 Importance of each attribute among segments of idea for river improvement

every attribute than that of conventional method. Figure 4.5 represents the importance of each attribute in terms of difference of flood drill activity. When inhabitants experienced flood drill activity, they have
more importance for forests along riverside and roads along riverside. On the other hand, when respondents do not have experiences of flood drill activity, they have more important for trees in a waterway compared with the other attributes.

Figure 4.6 shows importance of attributes in terms of the difference of river environmental improvement. The respondents who selected much of nature friendly method evaluated forests along riverside for more importance, but ponds in a waterway for less importance relatively. The respondents who have same rank for two methods evaluated trees in a waterway for more importance, but forests along riverside relatively. Moreover, the respondents who preferred the conventional method evaluated road along riverside for more importance.

4.5 Workshop discussions on specific design

On stage 1 and stage 2, the basic planning system was discussed. As a result, the basic policy and plan were considered as i) The river was improved as the shape for flowing flooding water safely, ii) The woods locating on the riverside or the floodplain are left as much as possible, iii) The floodplain is improved as the space where we can contact with nature, and iv) The access roads should be projected without the destruction of nature.

At stage 3, the specific design was examined in terms of the discussions in the workshop. And then, the temporal design is described.

Table 4.8 Results of sub-group discussion

Contents of design	A	B	C	D	E
1.Existing elm trees	Y	Y	U	Y	Y
2.river bed girdle	Y	N	Y	Y	U
3.riverside wood	Y	Y	Y	Y	Y
4.right slope gradient	U	Y	Y	Y	Y
5.existing ponds	Y	U	Y	U	Y
6.sandbank wood	Y	U	U	U	Y
7.left slope gradient	U	U	U	Y	U
8.observatory	U	Y	Y	Y	U
9.access roads	U	U	U	N	Y

Notes: Y: positive opinion, N: negative opinion, U: pending, for example, most of groups have positive opinions for existing elm trees.

Table 4.8 shows discussed contents for design.

On evaluation of the contents, the workshop was separated into 5 sub-groups and each group continued to argue the introduction of the specific shape. As a result, the different opinions are adjusted due to the arguments. The administrative sector gives information to the plan in view of the project budget and the technological possibility. The design is refined due to repeated arguments in the workshop more and more.. It was very important for each other to have the dialogue system among the stakeholders in the workshop. The group was adjusted by the rule of majority decision and the view of the whole workshop was represented as Table 4.9.

The workshop members in the group of the residents are required as

1) The riverside wood and families of elm trees are sustained in the existing condition, as much as possible.
2) The river bed girdle in and out of the shallow cut-off channel is established and the gradient of slope on new channel is from 1:2 to 1:10 corresponding to the role.
3) The area of ponds is secured for existing scale. The number of ponds is not decreased.
4) The observatory should be built, but the roads in the river are not constructed.

Based on these ideas, the possibility of realization has been discussed continuously.

Table 4.9 Consensus of the workshop

1	Planning the channel for preserving elm completely
2	The location of riverbed girdle is on plan.
3	The wood in riverside is preserved as much as possible.
4	The slope gradient of the right bank in the river is 1:10.
5	The scale and location of ponds are secured on the existing condition.
6	The wood in the sandbank is planned by using the left lindens.
7	The slope gradients of the left bank in the river are 1:0.5 with wood and 1:2 without wood.
8	The observatory is established in the top of bank.
9	The access road is not built in the river.

5. CONCLUSION

It was concluded the following contents in terms of Analyzing and adjusting the specific river environmental improvement:

1) After the discussion in workshops, they agreed to determine the policy of the excavation of mid-scale riverbed in existing waterway as an appropriate improvement system. This was evaluated for the most balanced idea between the aim of flood control and that of environmental protection in terms of fuzzy integral..

2) Such an idea was recognized by inhabitants through CVM based on the questionnaire. The concerns for the policy were very high and the value of total WTP was larger than the cost of the supposed improvement project.

3) Based on such a fundamental comprehensive plan, several alternative projects composed of several factors were proposed to inhabitants.

4) we developed evaluation method of alternatives for river improvement project taking the nature friendly method in was the optimal project of all alternatives due to Conjoint Analysis.

5) In the previous stage, the optimal or appropriate plan for river environment was established. It was easy to make a design, because the discussions were enough to adjust the different opinions and to get consensus.

In such a way, we built the system of decision-making involving administrative organization, the connecting experts section and community, that is, the platform of sustainability governance. Specifically, it is great that the function of workshop contributes to complete the governance. It is very important to adjust the different opinions among some stakeholders using such a platform.

Moreover, we introduced some effective methods as supporting system of decision-making. Actually, we used fuzzy integral, CVM and Conjoint Analysis. These are appropriate to analyze the ideas or opinions from inhabitants and to guide scientific information to the common stage of decision-making.

In the future study, the pilot system should be advanced and refined, adding more discussion stage and more useful methods. And then, the risk communication in the field of river improvement should be established due to the comprehensive system simulation.

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