The application of environmental governance for sustainable watershed-based management

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Abstract

In recent years, it has become popular for some of countries and regions to adapt the system of governance to varied and complex issues concerned with regional development and the environment. Watershed management is possibly the best example of this. It involves flood control, water use management and river environment simultaneously. Therefore, comprehensive watershed-based management should be aimed at balancing those aims. The objectives of this study are to introduce the notion of environmental governance into the planning process, to establish a method for assessing the alternatives and to develop a procedure for determining the most appropriate plan for environmental governance. The planning process here is based on strategic environment assessment (SEA). To verify the hypothetical approach, the middle river basin in the Tokachi River, Japan was selected as a case study. In practice, after workshop discussions, it was found to have the appropriate degree of consensus based on the balance of flood control and environmental protection in the watershed.

Keywords Environmental governance · Sustainable development · Watershed-based management · Strategic environmental assessment · Fuzzy integral · Delphi method

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1 Introduction

In recent years, it has become popular to adapt the governance system to varied and complex issues concerned with between regional development and the environment. Governance is generally composed of government, business and civilian society. In practical terms it involves various organizations and stakeholders in addition to the national and local governments taking decisions that affect others. Watershed management is possibly the best example of such sustainable development. Here, sustainability is based on striking a balance between human society and natural environment for future generations. Sustainability governance forms part of the environmental governance and can be defined as a framework within which the global environment for future generations is discussed and then determined (Asano and Takada 2014). It can also be regarded as governance that is future-oriented. Specifically, it is beneficial to make collective and comprehensive decisions in collaboration with the public sector, the private sector and civilian society. Collaboration between these sectors is necessary to tackle the broad and complex challenges of sustainability, and decision-making within such a framework is usually a collaborative process. The group should include all stakeholders who have an interest in a particular decision, either as individuals or as representatives of a group (Hemmati 2002).

After holding several stakeholder workshops, detailed policies are usually developed that play important roles in the decision-making process. This process has been a frequent topic of discussion and has led to the introduction of strategic environmental assessment (SEA) (Annandale et al. 2001). SEA is a systematic and comprehensive process for evaluating the environmental effects of the policy, plan or program system (PPP) and its alternatives at the earliest appropriate stage of the publicly accountable decision-making process, thereby ensuring full integration of relevant biophysical, economic, social and political considerations (Partidario 1999). The potential of SEA to improve governance has also been discussed on the basis of its ability to increase transparency, participation and inclusiveness by advocating a participatory and structured assessment process (Kidd and Fischer 2007). In SEA, communication, participation and reporting have important roles to play by introducing the perspectives and inputs of different stakeholders into the PPP-making process.

The objectives of the present study are to introduce the notion of environmental governance into decision-making, by establishing a method for assessing the alternative plans of the many stakeholders and developing a procedure for determining the most appropriate plan due to the planning process devised from SEA.

The discussion focuses on the river environmental improvement works.

2 Sustainable governance for planning regional environment

2.1 The basic role of sustainable governance

As mentioned above, sustainable governance involves utilizing all of society's capabilities and mechanisms. The 1987 Brundland 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 (Brundland 1984). According to this report, sustainability draws on the continuity and equilibrium of economic, social, institutional and environmental aspects to provide the optimum outcome for living and natural environment both now and in the indefinite future. Sustainability affects every level of organization from the local neighborhood to the global environment. Such activities are based on the idea of “think globally, act locally”.

To execute sustainable governance, the decision-making process should be constructed with regard to the SEA procedure. This approach provides decision-makers with better information on the impacts of alternatives in a proactive and systematic manner. Comprehensive notions of governance should contribute to the determination of sustainability in the regional environment such as river basin improvement. The synthesizing indicators are important for appraising sustainability. Moreover, those indicators differ from general economic indicators in that they reflect broader concepts including interactions between the environment, the economy and the particular society (Kagaya et al. 1995).

2.2 Analytical strategic environmental assessment

In Japan, it has been popular for either national or local governments to undertake infrastructure improvements, for example in relation to transportation systems and river environmental works, by means of the SEA method. This is because it is a comprehensive group decision system based on communication and phased decision-making using the PPP system. Figure 1 shows the planning procedure examined in this study based on the principle of SEA. It includes the preparation and use of some evaluation findings in publicly accountable decision-making (Therivel and Partidario 1996). In the present study, three procedural phases have been devised extending from Stage 1 to Stage 3 (Kagaya 2011).

- Stage 1: First, problem finding and checking are discussed by means of brainstorming and morphological methods. Using the results obtained by such methods, structure models are constructed by use of, for example, Fuzzy Structural Modeling (Kagaya 1991; Kagaya et al. 1995). These models are available for policy-making in the river environment project (Kagaya et al. 2004).
- Stage 2: In this stage, project planning is prioritized. Several alternative plans are generated by discussing how best to achieve the project aims. Next, the most appropriate plan is determined by means of multi-criteria analysis. The benefits are also estimated by the contingent valuation method (CVM). The CVM is frequently used to express a qualitative environmental value quantitatively (Kagaya et al. 2005a, Kagaya et al. 2007).
- Stage 3: The outline of the design is discussed with regard to basic factors of, for example, the regional environment. Conjoint analysis is then used to evaluate several designs in terms of specific attributes. On the basis of the

Fig. 1 Planning process for environmental governance

resulting alternative plan, a specific design is settled upon via the governance framework, which is composed of a number of stakeholders (Kagaya and Uchida 2006). In this stage workshop meetings are organized. The workshops are organized according to the governance framework. Here, various stakeholders in the workshops carry out wide-ranging discussions. The stakeholders participating in workshops consist of various interest groups such as administrative organizers, local residents, technical experts, consultants and members of non-profit organizations (NPOs).

It is important to note that these stages of analysis usually employ quantitative and statistical support methods. However, to put together the discussions at the workshop, the process may not change, and the design may be done by collecting opinions. In the two applications described below, the former is based on a quantitative method, the latter is based on an opinion aggregation method, such as the Delphi method.

Figure 2 represents a varied group of stakeholders that make up an exercise in environmental governance. The stakeholders are divided into four groups each different concerns. They are the interest groups of the environment, river use, flood control, and river management. The river management group mainly consists of staff from the administrative office. The key tool used by the environmental governance is a workshop meeting. The workshop membership basically consists of representatives selected through open recruitment in the groups concerning river environment,

flood control, river use. A facilitator or a moderator is also important to run the workshop meeting effectively. The term workshop was used originally to mean an atelier, where a craftsman works with originality and ingenuity. Here, the workshop is defined as an organization or society based on the above-mentioned concepts. More specifically, it is a place, where members participating can voluntarily create, learn and build a consensus through their combined experiences. Its significant effect is to capture emergent thinking.

It is important for the workshop's role in environmental governance to be based on the following process:

- (i) Determination of overall framework: based on the government's aims, the overall project framework is discussed and the relevant factors are determined. This is vital for understanding the policy and beginning the project.
- (ii) Selection of alternatives: based on the entire plan, several factors are selected and a number of alternatives arising from them identified.
- (iii) Determination and confirmation of the optimal alternative: based on public opinions and the workshop discussions, the optimal plan for river environment improvement is confirmed. Moreover, the workshop discusses the detailed design of the river basin environment. By carefully considering all opinions, a realistic design can finally be determined.

Fig. 2 Basic composition of environmental governance

2.3 Sustainability in river environmental improvement

A spatial plan for the river basin has an important role in considering sustainable development in the urban areas within the watershed. This is because the river basin is a fundamental space for both the living and the natural environments. That is, the river improvement should be concerned with balancing social activities and environmental protection. As mentioned above, the specific workshop is made up of residents, planners, NPO members and administrators as the stakeholders. Several factors that contribute effectively towards understanding inhabitants' concerns are introduced in the workshop. And then, a decision-making system related to sustainable river environment is developed under its environmental governance.

2.4 Existing conditions of the study area

As the study area, the middle basin of the Tokachi River was selected, as shown in Fig. 3.

The length of the middle basin is 12.4 km. It is located in the center of Tokachi district and contains a concentration of population and buildings. The total population in the area is approximately 250,000. The central city is Obihiro City. The area also has several tributaries with fast-flowing tributaries joining the main river in the area. It is necessary for the area to control abnormal flood flow by means of hard or soft measures. This is because the risk of flooding is increased due to the regional development and remarkably heavy rainfall. On the other hand, the residents need to have access to the parks built on the flood plain along the river. Moreover, some of the most important flora and fauna are also to be found along the river. They are necessary resources for tourism as well.

Table 1 describes the changes in natural and social land use in the river area.

Two decision-making problems were here prepared as discussion topics for sustainable governance of the river. One is to implement a flood control plan to sustain the environmental status of the basin. It aims to carry out an eco-friendly project of river works. The other is to design the environments in several sites in the river basin, considering both flood control and environmental protection. The former discussion is the decision-problem concerning an eco-friendly flood control plan for the most vulnerable site, namely, Site 4. The latter discussion is intended to present the specific example of sustainable governance using the Delphi method in the workshop. In this case, the overall middle basin is divided into seven sites, as shown in Fig. 3.

Case study area (1): Upstream of the middle basin

Case study area (2): Downstream of the middle basin

Fig. 3 Middle basin of the Tokachi River, Hokkaido

Table 1 Land use change from 1963 to 2005

Year	1963	1975	1991	2005
River water area	574	511	467	493
Park area	7	37	211	304
Meadow	600	608	603	416
Dry riverbed	830	763	395	339
Barren area	22	138	35	94
Grass land	621	973	949	351
Forest	891	319	723	1322

($\times 10^4$ m²)

3 An eco-friendly flood control plan for the river environment

3.1 Advanced flood control improvement

This sector shows the substantial results of eco-friendly flood control improvement. Since the new Japanese river legislation was enacted in 1997, it has become necessary to incorporate management including flood control, water use and river

environment into the river improvement project. The planning system, which takes into account consultation within the river basin, should be brought together with the components of the river environment improvement and conservation tasks, thus ensuring the improvement plans respond strategically to the needs of the inhabitants. Site 4 is located in a large meander stream, which seems to be the highest risk.

Extensive discussions to develop the methodology have been conducted over the years. The highest priority is to introduce public participation into the planning process. So far research has demonstrated the need for such a planning process. However, an even more elaborate strategic planning process is required, whereby various stakeholders are able to discuss and modify their ideas, as mentioned previously.

3.2 Inhabitants' views on the river environment

Before introducing the results of discussions within the workshop, the characteristics of workshop participants are compared with those of inhabitants in the study area. To make this comparison, ideas about the aims of river environmental improvement were prepared. These ideas were placed in the following six categories, A: flood damage prevention (flood control), B: river site access, C: familiarity with the natural environment of the river, D: progress of land use within the district, E: maintenance of the river natural environment and F: protection of flora and fauna.

Next, the importance of each item was hierarchically evaluated via the Fuzzy Structural Modeling (FSM) technique and compared with the opinions of residents and workshop members (Zahariev 1991). Table 2 shows the age structure of workshop members and the results obtained from the survey of residents and workshop members. According to these results, workshop members in their 40 s tend to be over-represented. Both groups of respondents have very similar preferences about the features of the river environment. This gives reassurance that the views of the workshop members are an accurate reflection of those of the inhabitants of the watershed.

Table 2 Age structure and results obtained by Fuzzy Structural Modeling

Age group	20–29	30–39	40–49	50–59	> 60
% of inhabitants	7	20	22	28	24
% of workshop members	8	13	46	23	8
Respondent	Preferential hierarchy by degree of importance				
Inhabitants	A > E = F > B = C = D				
Workshop members	A > E > F > B = C = D				

A–F represent elements of the river environmental improvement, the symbol ">" means superior and symbol "=" means indifference

3.3 Evaluation on eco-friendly flood control works

Here, another result is described based on the discussions and analyses in the workshops. River improvement is planned for a large flood- damaged site in the watershed. In this case, five alternative plans were prepared to select the most eligible one. The alternative proposals included: excavating a new waterway, excavating an intermediate water channel and widening the existing waterway; the full list of alternatives is shown in Table 3. The opinions of residents and workshop participants concerning the river improvement plan were ascertained via workshop discussions.

The five alternative projects were evaluated using a common set of criteria. The selected evaluation items (factors) included: (1) flood damage prevention (described as Factor 1), (2) riverbed access (Factor 2), (3) familiarity with the natural environment of the river (Factor 3), (4) promotion of land use within the district (Factor 4), and (5) maintenance of the natural environment (Factor 5).

Multi-criteria analysis (MCA) is introduced to decide on the appropriate alternative. This analysis is generally used for evaluation on a development project. The criteria here represent the effects associated with that impact. An evaluation method based on Fuzzy Integral is introduced here as a multi-criteria analysis. Usually, the degree of achievement of multiple indicators and their relative importance are used in the overall evaluation of the project. Therefore, the total sum of these two products is usually used. The evaluation due to Fuzzy Integral is computed using an extension of their importance to fuzzy measures (Yager 2015). As a result, the constraint of their additivity is removed, and it becomes possible to make an elastic evaluation of only monotonicity. Using the fuzzy measure, the Choquet integral can be applied to the calculation of the actual Fuzzy integral for comprehensive evaluation.

Table 4(a) shows that the degrees of importance were evaluated on a continuous scale from 0 to 1 as the fuzzy measures. This means that the larger the numerical value, the higher the expectation of the criterion. Table 4(b) indicates achievement scores of alternative projects on each factor. Table 4(c) shows the calculation result of Choquet Integral obtained using the above two survey values. In this analysis, Alternative 2 was recommended as the optimum plan indicating that a mid-scale riverbed excavation should be undertaken.

In another analysis it was estimated that the cost of this improvement plan would be JPY 1.5 billion. As mentioned above, the workshop was used to discuss plans for basic river improvement and ultimately the optimal plan was found in just such a workshop.

The next stage involved ascertaining whether the plan would be acceptable to inhabitants. That is, the following assumptions were presented to the inhabitants: (i) the river basin improvement would involve a new waterway through the sandbank, 400 m wide and 2 m deep, and (ii) a proportion of the budget would be used to incrementally widen the river basin area over a 20 year period. Next, we analyzed it using CVM to clarify the willingness to pay (WTP) of the local inhabitants. The workshop asked the inhabitants how much they would pay to support this project. In the survey, the payment card method was adopted, by which it is easy for respondents to choose the appropriate value. The WTP means the acceptable price at which consumers want to pay for a given unit of production. Here, it is defined as the price

Table 3 Alternative plans discussed in the workshop

Alternative plan	Content	Impacts
1. Excavation of new water channel with straight line	Excavation with straight line Modification of water channel width	Impossible to access sandbank Risk of blockage Risk of destruction of bird nests
2. Excavation of mid-scale riverbed within exiting water channel	Intermediate excavation with straight line Construction of some ponds within river site	Use intermediate bed only at times of flooding Use ponds for both flood control and water use Possible access to sandbank
3. Widening of existing water channel	Expansion of existing waterway Construction of floodwater storage area	Deforestation Risks of erosion of riverside Use ponds for both flood control and water use
4. Expansion of existing waterway and upstream improvement	Expansion of existing water channel Construction of floodwater storage area Change in waterway upstream	Large-scale deforestation Risk of erosion of riverside Use ponds for both flood control and water use
5. Excavation of new low water channel	Excavation of new shallow water channel	Risk of blockage owing to sedimentation High maintenance costs Water runs along the water channel all the time

Table 4 Evaluation of alternative projects due to the Choquet Integral

(a)Degree of importance for computing fuzzy measure					
Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	
$\alpha_1=0.25$	$\alpha_2=0.20$	$\alpha_3=0.16$	$\alpha_4=0.13$	$\alpha_5=0.35$	
(b) Achievement Score of Alternative Project on Each Factor					
Alternative project	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
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. Chnnel widening	0.3	0.5	0.8	0.8	0.1
4. Widening of upstream control channel	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
(c) Results of comprehensive evaluation					
Alternative projects	1	2	3	4	5
Evaluation value (order)	18.03 (3)	29.52 (1)	17.01 (4)	16.51 (5)	18.93 (2)

that can be paid when the environmental value acquired by the residents increases due to the river environment improvement project. In other words, when the Project 2 selected at the workshop is realized, the price paid by the residents is calculated. The CVM can be the most effective way to find WTP in the virtual market. In practice, a logit model based on random utility theory was used for model estimation. In this way, it was possible to evaluate the inhabitants' outcomes for river environmental improvement in relation to their attitudes and opinions, and to exclude opposition to expenditure funded by taxes (Hanemann 1984).

The results obtained from the CVM are represented in Table 5. The concern about river environmental improvement had a significant influence on the estimated WTP. The WTP per household was JPY 2,682 per year, and the present WTP value is JPY 37,900 for 20 planning years. The inhabitants, therefore, accepted the project, because the total WTP exceeded the total cost of the long-term plan and the provisional cost/benefit ratio was approximately 2.63 over 20 years.

Table 5 Total willingness to pay (WTP)

	Amount (JPY)
Annual WTP per household	2682
Accumulated WTP per household over 20 years	37,900
Annual total WTP of inhabitants in the district	279,000,000
Accumulated WTP of inhabitants in the district over 20 years	3,944,000,000
Cost of this improvement plan (in case of project 2)	1,500,000,000
(Benefit)/(Cost)	2.63

As a result, the inhabitants were willing to support Project 2 that had been selected by the workshop. On the other hand, the workshop examined several attributes of river environmental improvement. Two different levels of improvement were evaluated in the workshop for each attribute (factor). These levels are either nature friendly or the conventional (traditional) method. Figure 4 shows the results obtained using conjoint analysis, based on the data for the workshop members (Louviere 1994). Conjoint analysis is a statistical technique for determining the optimal product concept in marketing research. It is a method of calculating the degree of influence on the element, that is, the partial utility value by evaluating the overall utility value instead of evaluating the individual element. Here, several designs of the river environment were prepared and the most appropriate one selected. And then, the utility value of the importance and level of each attribute was calculated using the conjoint method (Kagaya and Shinada 2002).

As a result, the maximum and minimum levels of each attribute are obtained and the difference between them is the degree of contribution to that attribute. Figure 4 shows the result of the utilities of attributes obtained based on the data for workshop members. On the basis of every attribute, they supported Level 1, i.e., the nature friendly approach rather than the conventional ones. Moreover, Fig. 5 indicates the importance of each attribute for those members of the workshop with prior experience of river environmental improvement. Concerns for the maintenance of riverside forest and roads along the riverside are higher than those for other attributes. This is because the local inhabitants, including the workshop members, value highly the maintenance of the forests and roads in the river basin.

To progress more detailed decision-making, several sub-groups in the workshop focused their discussion at stages 1 and 2 of the planning process. Here, the following basic policy and plan were considered, that is, (i) the river environment should be improved to allow the safe flow of floodwater; (ii) the woods located on riversides or floodplains should be left undisturbed as far as possible; (iii) the floodplain should be improved and assigned as a space for inhabitants to interact with nature; and (iv) access roads should be improved without destroying the natural environment.

Fig. 4 Utility of each attribute evaluated by workshop

Fig. 5 Importance on each attribute obtained by conjoint method

3.4 Specific design in the watershed area

In stage 3, the specific design was examined in the workshop discussions. Then the provisional design was drawn up. Table 6 shows the design content as discussed in five sub workshops.

To evaluate the components, the workshop was divided into five subgroups (A–E) and each group continued debating the introduction of detailed designs in the project area. The administrative sector provided budget and technical information. The design was gradually refined following workshop discussions. It was, therefore, vital for each group to have a system for dialogue among the stakeholders at every stage. The group was governed in its decision-making by majority rule.

As the result of agreed adjustments in several meetings among all the subgroups, the workshop members from the residents' group required that:

Table 6 Evaluation of components of design for the chosen alternative plan

Component of design	Subgroup				
	A	B	C	D	E
1. Existing elm trees	Y	Y	U	Y	Y
2. Riverbed 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 place	U	Y	Y	Y	U
9. Access roads	U	U	U	N	Y

Y positive opinion, *N* negative opinion, *U* undecided (for example, major groups have positive opinions about existing elm trees)

- (i) The riverside woods and elm tree forest should be preserved in their existing condition as much as possible.
- (ii) A riverbed girdle in and out of the shallow cut-off channel should be established and the gradient of the new channel slope should be between 1:2 and 1:10 depending on its role.
- (iii) The number of ponds should not be decreased.
- (iv) An observatory should be built, but roads in the riverbed should not be constructed.

The overall consensus was summarized as the design principles as shown in Table 7. Those opinions can be regarded as the basis of river environmental governance.

3.5 Summary of section 3

The following points are pertinent in terms of analyzing and modifying the improvement plan for the particular river environment.

- (i) After the workshop discussions, it was agreed that excavating a riverbed in the existing waterway shallowly was the most appropriate improvement work, providing the best balance of flood control and environmental protection in terms of the Fuzzy Integral method.
- (ii) The local inhabitants recognized the plan through a CVM-based questionnaire. There were strong policy concerns and the total WTP value was larger than the cost of the proposed improvement project.
- (iii) Based on the primary comprehensive plan, several alternative projects were proposed to the local inhabitants.
- (iv) A method for evaluating alternative river improvement projects was developed. Following conjoint analysis, the nature-friendly method was found to produce the optimal project.
- (v) The optimal plan for the river environment facilitated design decisions, because discussions among stakeholders allowed for different opinions and enabled a consensus to be reached.

Table 7 Consensus of the workshop

-
1. The channel should be planned so as to preserve the elms completely
 2. The location of the riverbed girdle should be according to the plan
 3. Riverside woodland should be preserved as much as possible
 4. The slope gradient of the right riverbank should be 1:10
 5. The scale and location of pounds should be maintained in their existing condition
 6. Woodlands on the sandbank should be planned to make use of the remaining linden trees
 7. The slope gradients of the left riverbank should be 1:0.5 with woods and 1:2 without woods
 8. The observatory should be established at the top of the bank
 9. No access road should be built on the riverbed
-

4 Sustainable river basin management for future generations

4.1 Planning environmental improvements in the river basin

As mentioned in the previous section, a spatial plan for the river basin is important to considering sustainable development in a region. This is because the river basin is a fundamental space for both the social and natural environment. Therefore, it is necessary for future strategic planning to construct an environmental governance framework. This idea contributes to the creation of an holistic environment for future generations. The same workshop members were chosen from local inhabitants as in the previous section. Next, the items were introduced to contribute to understanding the concerns of local inhabitants. Finally, the decision-making system was established for the sustainable river environment.

Basically, this procedure depends on the planning process explained in Sect. 2. The practical example here is to advance the process of environmental governance by focusing on the river environment design of each site. Therefore, the emphasis was put on gathering the opinions of the workshop participants rather than quantitative analysis and focused on finding a coordinated design consensus. The Delphi method was adopted as the planning method.

Figure 6 shows the process of workshop meetings which extended from selecting common issues to confirming appropriate alternatives. The planning system, which takes into account various opinions from the river basin, should be added to the list

Fig. 6 Process followed by workshop meetings

of river environmental improvement and conservation tasks. That is, the improvement plans should be strategic and promoted in response to the needs of the inhabitants in the region.

The most important task was to introduce public participation into the planning process and complete the decision process during planning. The research has clearly demonstrated the need for such a planning process. However, an even more elaborate strategic planning process is now required. Thus, it is essential to construct governance in which the various stakeholders can discuss and modify their ideas.

The process here has five stepwise procedures. First, common issues are selected by the workshop. Next, alternative plans are generated and their possible components discussed. These steps correspond to stage 1 in the planning process mentioned in Sect. 2. Third, common issues are discussed and resolved. Fourth, common information on plans is shared among the workshop members. These steps are considered as stage 2 in the planning process. Finally, an appropriate plan is chosen and confirmed as a suitable design of each site. This step is regarded as the stage 3 of the planning process.

Here the Delphi method is used for achieving convergence of options from a varied panel of stakeholders. The Delphi method is a structured communication technique, originally developed as a systematic interactive forecasting method which relies upon a panel discussion. It is also adapted for use in face-to-face meetings, where it is referred to as mini-Delphi or Estimate-Talk-Estimate (ETE). In practice, a total of ten Delphi meetings were held throughout each of the study sites.

The fact is that forests in riverside areas have increased, replacing grasses in wetland area of the middle river basin. This is because water flow volume has reduced dramatically in recent years and the land in the riverbed has dried up. So it was divided into seven sites to discuss specific planning and designing issues. This made it easier to focus the discussion in each site and helped reach a consensus of planning river improvements.

4.2 Specific plans for improving the river environment

The results obtained from the workshop in which specific plans were examined in certain sites from the perspective improving of the river environment will now be examined.

(a) Selection of workshop members

The membership of the workshop consisted of some experts in the preparatory meeting, the watershed council members, the river consultants, the leaders of urban communities and some volunteers from the general public as mentioned previously. These volunteers are categorized according to what they thought about the river environment as shown in Table 8.

(b) Discussions in the workshop

Several opinions and ideas on the improving the river environment were proposed in the workshop based on existing survey and on-site inspections. It was confirmed that that site is significant for river environmental management to

Table 8 Justification for a member to participate in the workshop

Topic	Motivations for participation of workshop
Flood control	P-1: measures for flood control, safety from flooding P-2: concerns about relationship between river and flood prevention
Watershed use	P-3: participation in river improvement P-4: activities in the riverside for children P-5: tourism in a watershed environment
Watershed environment	P-6: properties of natural environment like wildlife, forests P-7: balance between river improvement and natural environment P-8: natural environment in the native area P-9: study of wild birds in the dry riverbed P-10: possibility of achieving the compatible river improvement P-11: river environment to be suitable for fishing P-12: developing an environmentally friendly method of river improvement P-13: examining policies for creating an environment friendly

preserve the colony of bank swallows, the habitat of kingfishers, and some plants such as *Salix arbutifolia* (species of willow).

- i. The environment, such as the natural riverbed with stones or grass cover and forests of riverside, has decreased. So it is necessary to remove obstacles from river flow and restore the natural flow.
- ii. To attract tourists it is desirable to conserve sandbanks and cliffs, where there are habitats.
- iii. It is necessary to construct a river improvement plan with a comprehensive range of functions such as flood control, the use of river water or river space and the protection of the river environment.
- iv. Flood control is a serious measure for people living close to the riverside.
- v. While it is necessary to conserve wands (lagoons), rapids and abysses, it is difficult to sustain them. We need to understand the characteristic features of the natural river and build the technology of improvement.

These are some of the basic views expressed about improving the river environment. Based on such views, the aim for workshop discussion was to achieve river management that sustains safety for flood control while at the same time retaining biological diversity. Specifically, the river improvement works should be carried out by combining river excavation and logging as flood control and the riverbed and wetland restoration as the conservation of the river environment.

(c) Devices for promoting the workshop

Here, the workshop was designed to cover the following aspects;

- i. The workshop members made site visits and shared opinions when they had to decide whether or not the forests of riverside should be cut down. It was easy to build that consensus as a result of the site visits.
- ii. It was also easy to imagine the future river environment, because the trial site included such features as a small pond and a changed river flow.
- iii. The workshop members could have discussions based on their own common sense. If it was necessary to adjust different ideas, they sought input from local inhabitants interested in the project and gathered more detailed information about the region that contributed to consensus.

(d) Method of achieving consensus

It is important when formulating an appropriate river environmental improvement plan to think about the decision-making process in the governance system. Therefore, in this study, we introduced the following procedure:

- i. Establishing a kick-off plan by means of the administrative sector: the environmental governance is composed of the administrative sector and various workshop members. First of all, the administrative sector begins their action of planning river improvement. Their kick-off plan is based on a standard method, mainly by reference to a manual. The discussions in the workshop started once such a basic plan has been proposed.
- ii. Offering opinions for alternative plans due to workshop: the discussions begin in the workshop, when the kick-off plan was proposed by the implementation body. Different ideas for the plan would usually emerge from subgroups in the workshop. In most cases, the opinions are incompatible, so that some different alternatives needed to be generated before proceeding to the next stage.
- iii. Making different alternative plans: the administrative sector makes alternative plans based on the opinions expressed in the workshop. In this case, the alternative plans depend on the number of members accepting their ideas and then the alternatives are offered to the subgroups of workshop. If there is a disagreement, further mini Delphi method meetings are held until agreement is reached.
- iv. Inspecting the on-site conditions: it is necessary for workshop members to confirm the on-site conditions for further discussions. After that, the members resume discussions in accordance with the Delphi technique.
- v. Adjusting plans and deciding the appropriate plan: finally, plans can be adjusted by means of the Delphi technique.

After the final discussion, the appropriate plan for improving the river environment can be chosen from some alternatives. The feedback of interaction between the implementation body and the workshop is represented in Fig. 7.

(e) Apply the Delphi method to obtain consensus

Fig. 7 Feedback process between workshop and implementation body

As mentioned earlier, the Delphi method is a means for structuring a group communication process. It was mainly developed by Dalkey and Helmer (1993). Delbecq et al. (1975) indicate that the Delphi method can be used for developing a range of possible program alternatives. It can also be utilized for seeking out information that may generate a consensus on the part of the respondent group (Hsu et al. 2007).

The procedure of Delphi method introduced here is represented in Fig. 8.

In this case, n rounds of the Delphi trials are used. First, we examine the problem comprehensively and define several alternatives. And then, we discuss the alternatives and evaluate some ideas as the first round of the workshop. If the agreement of an appropriate idea is achieved, the meeting finishes. In practice, however, this is rarely the case. So we carry out the first Delphi round. In this round, we collate and summarize the responses removing any irrelevant content and looking for common viewpoints. Based on the first round, we make an intermediate summary for the first responses and elaboration on the ideas. Rounds are repeated again and again until the appropriate agreement is obtained (usually n rounds). If it is reached, we declare such a consensus as the final result.

Here, we apply this technique to put all members' opinions together and obtain a consensus. The proposals are discussed in the subgroup meeting. And then, results are obtained from different subgroups. After choosing the alternatives there, further discussions are made to reconcile the overall views. Finally the appropriate overall consensus is achieved in the workshop.

4.3 Plan for river improvement works

(a) Plan in seven sites in terms of discussions in subgroups of the workshop

In the first stage, we discussed some basic ideas for plans of river environmental improvement in each subgroup. Table 9 shows the results of the cohesion of ideas generated in the first stage using the Delphi method for the design of seven sites in three subgroups.

Fig. 8 Proposed procedure of Delphi method (in the case, where there are n rounds)

Table 9 Results at the first stage discussed in workshop subgroups

Subgroup Site No	A	B	C	Points of discussion
1	Make sparse wood	Preserve forest	○	Examine sparse wood and preserve forest
2	○	○	Cut the trees down on the left bank, reduce the width of evacuation to right bank and make sparse wood on the left bank	Examine the method of cutting down and evacuation
3	○	○	○	
4	○	○	Reduce width of forest and reduce width of evacuation to right bank	Examine the width of forest preserved
5	○	○	○	
6	○	○	○	
7	○	Preserve forest of the riverside and evacuate the river behind the forest	○	Examine the method of evacuation

○ means the same idea in each subgroup as the primary plan

Fig. 9 Results of bringing opinions in each subgroup of the workshop

The circles in the table indicate that each subgroup agreed with the proposals of the implementation body. Namely, each subgroup achieved a consensus for a plan design. On the other hand, in the case that the comments are listed in the cells, opinions of the subgroups were different from the implementation body. In next

Fig. 10 Alternative kick-off plan on Site 2 (First proposal)

stage, those different opinions were made as alternative designs used by the Delphi method.

(b) Discussion of river environmental improvement on a specific site

As a typical example, consensus building at site (2) is described. Site (2) can be considered as a typical urban river basin with most population and assets concentrated among all the target sites. That is, this site is adjacent to the downtown of Obihiro City, the largest city in the middle basin and Otofuke Town. The riverbed site is used as a park for such sports as baseball, football and so on. It is also an area, where a forest in the riverbed is growing densely.

Site 2 is in Obihiro City which is located on the right bank and upstream of the middle basin. On the other hand, the left bank adjoins Otofuke Town. Both banks have plenty of forest cover in the riverside.

The opinions expressed in the discussion workshop are shown in Fig. 9.

- i. Foxes are observed living in the forest riverside leading to increased fear of echinococcus virus. Besides, some people dump waste around the site illegally. Therefore, some workshop members insisted that a part of the forest should be cut down.
- ii. The retaining wall blocks should be maintained to preserve the riverside environment.
- iii. The width of the river should be extended to flow freely.
- iv. The shoal in the riverside should be sustained.
- v. Safety from floods should be ensured in terms of excavation of the bank side.
- vi. It would be preferable to excavate the right side bank and preserve the riverside forest.

Fig. 11 Results of on-site inspection on Site 2

Fig. 12 Final consensus plan of site 2 obtained workshop meeting

To begin with, the administrative office proposed the first plan based on various opinions, as shown in Fig. 10.

That is, this plan is for the forest near the housing area to be thinned out in terms of considering the living environment of residents and the other forests were left. And the high-water bed in the right bank area was excavated to 50 m wide. Some of the openly recruited members among the residents felt it was necessary to take action. Thus, the opinions among members were divided into two different ideas, which should cut down the forest of riverside down or should preserve it. Then, on-site inspection was executed to decide the appropriate plan for the river improvement works.

From on-site inspection, it was confirmed that three different forests existed in the study site. These are the forest of young willow, namely, the forest of dominant species, Japanese poplar forest and the large-scale forest including *Salix arbutifolia*, as shown in Fig. 11.

After inspection, the workshop reconsidered the plan for river environment improvement based on the following points:

- i. The willow is very popular and so too are Japanese Poplar trees in the Tokachi River Basin. It is not so important to sustain such species.
- ii. On the other hand, *Salix arbutifolia* is known to be a rare species to be found only in the Tokachi district and in a part of Nagano Prefecture in Japan.
- iii. It is easier for a fox to live in thinned forest compared with dense or completely cut down forests.
- iv. It is necessary for birds to live in continuous forests by about 10 m width.

Table 10 Final consensus obtained in the workshop discussion

Site	Left side bank	Right side Bank	Center of the River
1 (2)	Cut woods down Build grass land Leave riverside woods 10 m width	Do nothing special	Sustain small island in the river
2 (3)	Cut forest down and thinning, preserve special willow	Excavate river bed by 30–40 m width	Do nothing special
3 (1)	Excavate riverbed level, create dry riverbed and maintain branch flow	Excavate riverbed	Sustain small island in the river
4 (3)	Do nothing special	Preserve riverside forest by 50 m width and cut down back woods	Excavate and create wetland
5 (2)	Sustain continuous forest, excavate riverbed level and try forest recreation	Do nothing special	Do nothing special
6 (1)	Excavate riverbed level	Preserve nest of martins	Cut down woods in the river and create dry riverbed
7 (3)	Create grassland in the river side	Leave water area in the high water level	Excavate riverbed

Number in brackets represents discussion rounds for making the consensus by Delphi technique

- v. While the woods flourish in the riverbed, the grass areas decrease more and more in recent years.

As a result, Fig. 12 is the adjusted plan on the site 2. It includes the forest with *Salix arbutifolia* and forest 10 m wide in riverside is retained on the left bank. Furthermore, it also includes ensuring the discharge capacity of the river by excavating the river bed by 30–40 m on the right bank side. Thus, it was possible to achieve consensus on the adjusted plan.

(c) Results of discussions on whole sites

Table 10 represents the results of consensus discussions on whole sites. Discussions for adjustment by the Delphi method were promoted in each site. Here, as for the alternative designs at each site, one to three plans were selected by the workshop meeting. The original proposed by the implementation body was also included as one of designs in each site. Those proposals consisted of three parts of a site, namely the left side bank, right side bank and center of the river. The round meetings of the Delphi method were carried out from one to three in each site as shown in the table. In most of the sites, the natural environment was sustained as much as possible. Namely, logging forests and excavating riverbed should be considered for natural conditions in the river environment. That is, most participants insisted on keeping it in its original shape, to promote flood control. So it is necessary to maintain the balance among such aims in the river environment.

The planning process for environmental governance is basically a system for making decisions by utilizing the functions of administrative bodies and communities while seeking cooperation. Therefore, such a procedure is not directly taken into account in this case. However, the designs were prepared in three stages of the PPP with the help of the government and the participation of the community as needed. In other words, the procedures shown in Fig. 1 such as identifying the issues, generating the alternative plans, determining the appropriate plan, and implementing the design are utilized in this example.

4.4 Summary of section 4

The following points are relevant to analyzing the improvement plan for the special river environment:

- i. After the workshop discussions, each site was found to have a detailed improvement plan that is based on consensus among the members with different views and ideas.
- ii. It was helpful for workshop members to apply a flexible Delphi method to achieve the appropriate consensus.
- iii. When it is difficult to form a consensus, it is prudent to confirm the situation and phenomena by site visits and share a common perception.
- iv. Dynamic consensus building by the Delphi method at the workshop enables the creation of reasonable plans. In this way, a process from proposing the

motivational plan to building the consensus based on the Delphi can be a way of thinking that contributes to the construction of environmental governance including sustainable environmental governance.

- v. Finally, the optimal plan for the river improvement facilitated design decisions, because discussions among stakeholders allowed for different ideas and enabled a consensus to be obtained.

5 Conclusion

In this paper, the improvement plans for the sustainable river environment were considered by discussing two practical examples. For the sustainability of the river environment it is essential to base discussion on regional environmental governance. The governance consists of multifarious stakeholders who have diverse ideas. Such advanced ideas were developed by means of the workshop. The workshop has a critical role on governance decision-making.

In the former example, several analytical techniques like the fuzzy integral method, CVM, the conjoint analysis and so forth supported workshop discussion. Such quantitative analyses were introduced effectively. As a result, the connection between administrative organization and a number of experts in the community created a system of decision-making. To summarize the result of Sect. 3, it was agreed that shallow excavation of the riverbed of existing waterways and installation of belt works across the river would be an environmentally friendly flood control method. As a result, the natural environment of the river was preserved as much as possible, and it was recognized as a new construction method different from the conventional one.

The latter example showed how to choose an appropriate alternative in terms of an adjustment method of meeting, namely, the Delphi method. This is an extensive Delphi method. Using it, the discussion settled after several rounds. So a specific landscape design was developed for every site in the river basin. According to the summary of the results, the detailed river environment design decisions led to consensus building by environmentally friendly policies, evaluation of several alternatives and decision plans, the creation of concrete design programs based on them, and the planning process.

These two methods of application are slightly different. The former considers a planning system by combining analytical methods, and the latter considers it in the form of consensus building. However, they are based on the stepwise process of the planning system which adopted the SEA method defined at the beginning. From this point of view, the basic ideas of the planning system are applicable generally and flexibly.

In future studies, the consensus should be advanced and refined at additional discussion stages and other useful methods and techniques employed. In addition, governance in the field of river environment planning can be developed more gradually

and sustainably by applying new simulation techniques like multi-agent system to future scenarios.

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