MANAGEMENT STRATEGIES FOR TAIWAN SHIMEN RESERVOIR CATCHMENT AREA: PERSPECTIVES OF COLLABORATIVE PLANNING

Hun-Feng Huang[1]*
Department of Public Administration and Policy
National Taipei University
New Taipei 23741,Taiwan, R.O.C.
&
Water Resources Management and Policy Research Center
Tamkang University
New Taipei 25137, Taiwan, R.O.C.
E-mail: hhf@water.tku.edu.tw

Hen-Chin Chen
Department of Public Administration and Policy
National Taipei University
New Taipei 23741,Taiwan, R.O.C.
E-mail: hcc31699@ms41.hinet.net

Sean Liu
Water Resources Management and Policy Research Center
Tamkang University
New Taipei 25137,Taiwan, R.O.C.
E-mail:Sliu@water.tku.edu.tw

ABSTRACT

In Taiwan there are 113 reservoir catchment areas delineated as public water source protection areas covering 25% of the country's land area. Many important reservoir areas are vulnerable to global climate change, and water resources are already under increasing ecological, societal, hydrological and economic pressures. In this research, a case study of Shimen Reservoir catchment area management was constructed. The research utilizes the collaborative planning model. Thirteen factors under the categories of "land use", "water quality protection", "quantity of water supply and demand", "water and soil conservation", and "laws and institutions" were identified and corresponding response strategies are proposed. In order to optimize the use of limited government budgets and resources, the factors and corresponding response strategies were assessed and ranked in terms of their comparative impacts. The Analytical Network Process (ANP) was

[1] *Corresponding author

employed in this research for quantifying multiple stakeholder's' perceptions of the above mentioned factors and response strategies. The ANP results show that "national land planning" is the most important issue, under which "the extent of land use" is the strongest factor. "Public participation" is shown to be the strategy of the highest priority, under which land development's environmental impacts need to be reviewed, and an information management platform needs to be established so that value added analysis can be performed in support of catchment management strategic planning.

Keywords: Reservoir Catchment Area, Collaborative Planning, Analytical Network Process

1. Introduction

In Taiwan there are 113 reservoir catchment areas delineated as public water source protection areas covering 25% of the country's land area or a total of 8,972 square kilometers. The water source preservation sites cover a massive area and as a result multiple jurisdictions and the involvement of multiple management units, and therefore factors that influence water quality and quantity control are already under increasing ecological, societal, hydrological and economic pressures (Huang, Chen & Liu, 2014). In this research, a case study of Shimen Reservoir catchment area management is constructed. The catchment area of Shimen Reservoir is about 763.4 square kilometers. The Shimen Reservoir is located on the mid-stream reach of the Dahan River which is Taiwan's third largest reservoir and artificial lake. Completed in 1964, the dam and reservoir now supply water to more than three million people in northern Taiwan. The reservoir has been operated for over 50 years to serve the 5 originally planned functions; i.e., irrigation, hydropower generation, public water supply, flood mitigation and tourism. Over the years, the Reservoir has significantly contributed to agricultural production, industrial development, enhancement of living standards, increase of employment opportunities, and alleviation of flood and drought disasters in the northern Taiwan region. Shimen in Chinese means stone gate, and the reservoir site has been so named because at the mouth of the river a pair of huge rocks on either side of the bank look like a stone gate.

This study utilized collaborative planning, through in-depth interviews with stakeholders, to construct key issues that the catchment management in the Shimen Reservoir now faces. Through team brainstorming and expert consultation, thirteen factors under the categories of "land use", "water quality protection", "quantity of water supply and demand", "water and soil conservation", and "laws and institutions" were identified and corresponding response strategies are proposed. In order to optimize the use of limited government budgets and resources, the factors and corresponding response strategies were assessed and ranked in terms of their comparative impacts. Lastly, the Analytical Network Process (ANP) (Saaty & Saaty, 2003) was employed in this research for quantifying multiple stakeholders' perceptions of the above mentioned factors and response strategies. Additionally, investigation of recommended research and analysis development was discussed in order to provide reference for future implementation and research tactics for the current government. In order to know more about the management problems of the Shimen Reservoir catchment area, this study conducted site visits by using qualitative approach stakeholder interviews. We conducted 18 interviews with

stakeholders representing different authorities and policy communities related to our topic. A summary of the interview participants is shown in Table 1.

Table 1
Interview participants

General Classification	Interview Units
Relevant Authorities （7 events）	Northern Region Water Resources Office, WRA
	New Taipei City Government
	National Land Planning Team, Ministry of the Interior
	Forestry Bureau Watershed Management Division ,COA
	Land Management Department, Council of Indigenous Peoples
	Taipei Branch Soil and Water Conservation Bureau, COA
	Water Quality Protection Division, EPA
Local representative society （3 events）	Flood Control Oversight Union
	Green Formosa Front
	Lo-Fu Elementary School
Local business （2 events）	Lung Chu Holiday Village
	Xiao Wu Lai Vacation Village
Township offices or representatives （3 events）	Da-xi Township, Tao-yuan County
	Jianshih Township, Shin-Chu County
	Fu-Hsing Township, Tao-yuan County
Relevant scholars and experts （3 events）	Water Environment Research Center, National Taipei University of Technology
	Te-Chi Reservoir watershed Management Committee
	Disaster Prevention Center, National Chiao Tung University

We constructed four key discussion points that are of concern to the management of the preservation sites at Shimen Reservoir by utilizing content of local interviews with stakeholders as well as taking account of the compiled results of related documents. The discussion points are “land management”, “rules and regulations”, “execution”, and “environmental justice” (Water Resources Agency, 2009a).

This includes discussion articles as follows:

(1) Land management issues
   a. Illegal usage of national forests
   b. Over-utilization of land
   c. Compensation to areas near silt dams and preservation sites near the reservoir
   d. Concurrence of preservation sites near reservoir and urban planning

(2) Issues regarding rules and regulations
   a. Lack of overall planning of preservation sites and mechanism of integration
   b. Lack of a platform to coordinate all levels of ministry

(3) Execution issues
   a. Lack of manpower in the executive branch
   b. Unable to implement laws to suppress illegal jobs due to public opinions

(4) Issues of environmental justice
   a. Source of income for local residents
   b. Publication of information and participation of people

These issues that water preservation sites near the Shimen reservoir now face, and the analytically compiled results of interview records and related documents regarding Taiwanese water preservation sites (Water Resources Agency, 2009b) were reviewed in hopes of constructing five main aspects that the management of Taiwanese catchments and similar environments now face. Key points for discussion under these five issues include "land use", "water quality protection", "quantity of water supply and demand", "water and soil conservation" as well as "laws and institutions".

2. Hypotheses/objectives

The so-called 'collaborative planning' means people who live close together construct new ways of solving problems, thinking and acting through being embedded in multiple joint relationships. (Healey, 2006) It looks at how to form a cooperation culture, integrating the local residents, the relevant authorities and stakeholders in order to create policy learning through dialogue, and seeking consensus on issues of common concern. According to this definition we know that collaborative planning attaches importance to the social relationship system and social learning communication. The former emphasizes the ability to build relationships, expecting to cross the system fragmentation caused by cultural barriers, organizational division of labor and power, while the latter is conducive to social mobilization, and reorganizing people who are socially marginalized. This inclusive plan has a multicultural nature. It helps to develop cooperation, communication and to build relationships of mutual understanding and trust. In addition, collaborative planning activities are conscious policy-driven and try to reach three goals by embedding the views of strategic, long-term, and mutual relationships into the governance process. These three goals are: (1) To help build relationship capacity by informing the political community and stakeholder's views on related issues, (2) To form a field for the stakeholders to exchange views, and (3) By forming the means of solving problems to help form the cooperation of new ways of thinking and actions or reconstructing the procedures of dealing with the problems.

In order to reach these goals, we need to design a system with systematic processes (Healey, 2006). The so-called 'system' refers to different types of entities, including the norms, actors expectations, and organizational rules. It links the interactive organization and the behavior of the members acting in accordance with the system (Ostrom, 2007). In essence, the system has some common characteristics: (1) the system is a product designed by humans which means the system needs to change with the environment's affection or human needs, and (2) the system can not only regulate individual's behavior patterns but also construct serious ways of environmental, economic and social interaction to reduce the uncertainty of human society because of its feedback mechanisms.

As E. Ostrom (1999) said, we will be able to understand the meaning of the system more when we actually use the rules. A cooperation plan is a conscious policy-oriented plan which tries to embed the views of strategic, long-term, and mutual relationships into the governance process. Its goal is to look for a win-win result and avoid the participant's different perspectives which could cause a win-lose result. Therefore, it forms an inclusive discussion through the system design in order to solve the dilemma of the coexistence of advantaged and disadvantaged groups. The links between the rules and the system features can establish different types of system arrangements between the actors and the rules. The emphasis of collaborative planning is based on formal resources. It receives stakeholder's attention and makes them be active participants in discussing and cooperating on risk issues, and thus shapes the essence of actions.

More specifically, the factors we need to consider during the whole policy process include the actors, results and the policy itself. (Ostrom, 2007) When everyone holds different views with regards to a problem, frame conflict exists because of different explanations of the issues. Therefore, both sides will have difficulty appealing to reason and developing solutions when there is a lack of standard protocol specification. That is the reason why policy issues happen (Schön and Rein, 1994).

Schön and Rein (1994) call the policy stance built by belief, perception and appreciation 'frame'. In fact, 'frame' is deeply rooted in the system and related to the interests that people desire and fight for closely. Interests shape the 'frame' and make the stakeholders enter the subject areas and move to defend their interest and cause the frame conflict. Stakeholder's different levels of awareness of policy issues affect the strategy of problem solving. The catchment area this study talks about is very large, crossing different administrative areas and involving many management units which causes a structural problem that makes it hard for stakeholders to come to a consensus about ways to solve the issues. In order to practice the cooperation and collaboration that a cooperation plan emphasizes, the government needs to take the stakeholders' opinion into consideration when they are in the planning process.

Generally speaking, the collaborative planning process includes six stages as illustrated in Figure 1. The stages are: (1) defining the problem, (2) establishing an assessment standard, (3) developing alternative programs, (4) comparison of alternative programs, (5) selecting an alternative program, and (6) conducting evaluation.

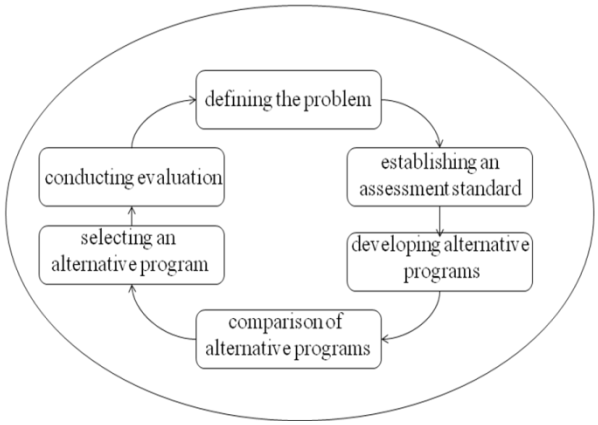

Figure 1. Diagram of collaborative planning (Source: Patton & Sawicki, 1986, p. 26)

This study uses the theory of collaborative planning as well as the Analytical Network Process (ANP). Through interviews with stakeholders affected by the policy, we recompiled influencing factors regarding the management of the research on water preservation sites as well as alternative program strategies. By gaining a better grasp of key aspects and influencing factors, we can provide consultation for future government administrations and develop important strategies.

3. Research design/methodology

In order to put cooperation into practice, the opinions of those whose interests are affected by the policy must be included during the planning phase of the process.

3.1 Stakeholder classification

The earliest method of stakeholder classification started with R. E. Freeman (1984) by using the strategic management point to define 'stakeholder' as "any group or individual who is affected by the organization goals or who can affect to reach the goals". In regard to public policy, this means anyone who is affected by some problem directly or indirectly or who is accepting positive or negative affection directly or indirectly after the government institute takes any step (Wu D., 2008). Chang-Tay Chiou (2013) further divided stakeholders into three categories: (1) policy makers: the individual or group who makes, uses and executes the policy; (2) policy beneficiary: the individual or group who gets the benefit directly or indirectly; and (3) policy victims: the individual or group who loses because of misconduct of policy design and side effects. Following R. Mitchell's way, this study divides stakeholders into seven types according to power, legitimacy and urgency as shown in Figure 2. Power refers to the ability the stakeholders have to affect the agenda or decisions. Legitimacy means the appropriate relationship between the stakeholders and the issues. In other words, is it reasonable or appropriate for the stakeholders to have an interest? Urgency means the stakeholders need to raise the issues immediately and need of the government to respond right away. It is worth noting that the position of the stakeholders is not absolutely constant, and depends on their power, legitimacy and urgency. This study attempted to classify the stakeholders using these features according to the specific case, and used this as a basis for choosing interviewers.

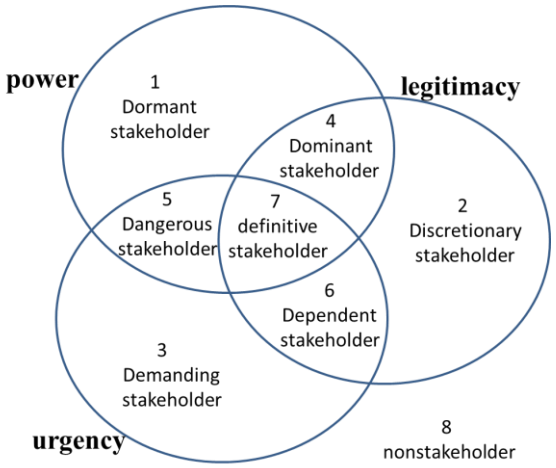

Figure 2. Stakeholder typology: One, two, or three attributes present
Source: Mitchell, Agle & Wood (1997, p. 874)

3.1.1 Definitive stakeholders: This type needs to possess all three characteristics. Once their request is made, it should be the first priority for the government to consider and develop clear laws to fit their need.

3.1.2 Expectant stakeholders: This type needs to possess at least two characteristics. They usually take a proactive approach, so the pressure of the government response will relatively increase. We can break it down into three categories according to their own characteristics.

3.1.3 Latent stakeholders: This type only has a single characteristic, therefore the government does not fully respond to their request. We can break it down into three categories according to their own characteristics.

3.1.4 Non-stakeholders: This type possesses no characteristics.

This study conducted an ANP questionnaire survey which included 9 experts who are very knowledgeable about management of catchment areas. They represent different institutes and professional backgrounds which are shown in Table 2. Table 2 also includes the classification principle of policy stakeholders discussed by Mitchell (1997).

Table2
ANP questionnaire survey interviewers list

Interview Unit	Covers property stakes	Interviewer's title
Taipei Water Management Office, Water Resources Agency, Ministry of Economic Affairs	2、4、7 (legitimacy)	Director
Conservation Division, Water Resources Agency, Ministry of Economic Affairs	2、4、7 (legitimacy)	Leader
Northern Region Water Resources Office, Water Resource Agency, Ministry of Economic Affairs.	3、6、7 (urgency)	Deputy Director
Deji Reservoir Watershed Management Committee, Ministry of Economic Affairs	3、6、7 (urgency)	Executive Secretary
Water Resources Agency, Ministry of Economic Affairs	1、4、5 (power)	Consultant
Institute of Environmental Engineering, National Taiwan University	1、5 (power)	Assistant Professor
Department of Civil Engineering, Taipei University of Technology	1、5 (power)	Professor
Tamkang University	1、4 (power)	Professor
Taiwan Typhoon and Flood Research Center	1、4 (power)	Deputy Director

3.2 Analytic Network Process (ANP) application

In order to understand the priorities of those whose interests are affected, the opinions of each related group were analyzed and categorized by the influencing factor of their judgments through the Analytic Network Process (ANP). Our research of the procedure of ANP's application is shown in Figure 3. ANP's basic structure can be classified into four main points: evaluation and comparison of the systematization of complex comparisons and assessments and setting the scale, establishment of pairwise comparison of matrices, prioritization of vectors and maximizing the eigenvalue, and testing for consistency (Saaty and Saaty, 2003).

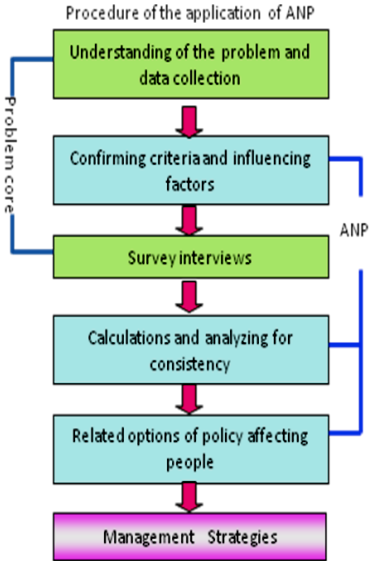

Figure 3. Procedure diagram of research application

3.2.1 ANP hypothesis

The ANP method is an extension of the AHP method, and therefore there is a great deal of similarity between the two. The AHP method holds the following principles (Seldtani & Takahashi, 2001）:

(1）A system can be decomposed into many types, and forms a straight line shown in the hierarchy;
(2）It is assumed that the factor of each level is independent;
(3) The factor of each level can be evaluated based on the factor of the last level;
(4）While conducting comparison evaluation value scale can be converted into ratio scale;
(5）After conducting pairwise comparison, pairwise comparison of matrices to process;
(6) Preference relations satisfy transitivity and not only the advantages and disadvantages but also the strength satisfies transitivity at the same time;
(7) It is not easy to have full transitivity, therefore it is permissible to have non-full transitivity existence;
(8) The advantage of the factor can be obtained by weighted law;
(9) As long as any factor shows up in the hierarchy, it doesn't matter what level the advantage is, it is still considered to be related to the whole evaluation structure and not the independence of the hierarchy checklist.

All except the first two basic assumptions of the AHP method above are applicable to the ANP method.

3.2.2 ANP's steps

The Analytic Network Process (ANP) can be divided into eight steps:

Step 1- Define the problem: According to the nature of decision problem, can list the factors which might affect the problem, and collect related information in order to summarize the decision problem.

Step 2 - Decide the decision-making group: Based on the domain of the problem, bring in scholars and experts from the related fields to form a decision-making group.

Step 3- Create the problem's network hierarchy assessment model architecture diagram: After collating and summarizing the information of decision problems, determine the factors that affect the decision problems including the goal, evaluation standard and backup plan. In the problem structure every level has a dependent and feedback relationship.

This study consulted the in-depth interviews and related documents in order to determine five aspects of the aforementioned main issues. Through team brainstorming and expert consultation, five main criteria were created to evaluate each aspect and to list possible deciding factors of each aspect (thirteen in total). Furthermore, eight alternative methods were proposed in accordance to management issues, thus creating the layered network structure of ANP shown in Table 3. A map of the relationship network of the ANP was constructed and is shown in Figure 4. The analysis was conducted using SuperDecisions^{TM} software (Creative Decisions Foundation, Pittsburgh, PA, USA).

Table3
Evaluation aspects, influencing factors and alternatives

Criteria	Factors
A. Quantity of water supply and demand	A-1 Changes in surface runoff
	A-2 Decrease in reservoir capacity
	A-3 Downstream water requirements
B. Water quality protection	B-1 Waste water emission
	B-2 Source water turbidity
	B-3 Reservoir eutrophication
C. Water and soil conservation	C-1 Collapse of sloping fields
	C-2 Ground vegetation
D. National land planning	D-1 Environmental and geological properties
	D-2 Intensity of land usage
E. Coordination and communication	E-1 Obtainability of basic environmental data
	E-2 Information sharing and applicable benefits
	E-3 Public knowledge and participation
Alternatives	
1. Post-exploitation environment impact analysis	
2. Ground surface monitoring system	
3. Water environment monitoring	
4. Reduction of pollution and improvement measures	
5. Water supply potential and demand assessment	
6. Landside control	
7. Information platform settlement and value-added data analysis	
8. Public participation	

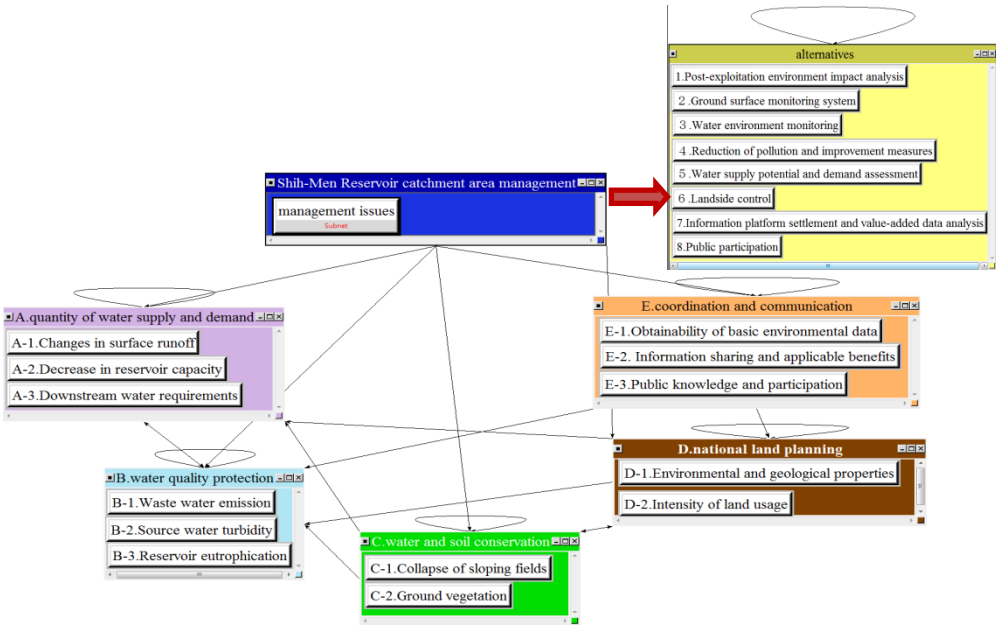

Figure 4. ANP relationship network map (using SuperDecisions™ software)

Step 4 - Pairwise comparison evaluation: After a network hierarchy structure is built, evaluate the same level's relevant importance of different evaluation factors. The appraisal method is based on the last level's factor to pairwise compare the importance from this level's factors to the last level's factors. This can decrease the burden on the decision-makers thinking, and can also show the relativity of decision factors more clearly. The Analytic Hierarchy Process uses nominal scales as the evaluation standard which is divided into a nine-point scale as shown in Table 4.

Table 4
ANP's evaluation comparison scales

Rating Scale	Definition	Explanation
1	equal importance	The comparison of two programs are of equal importance
3	moderate importance	Experience and judgment shows slightly in favor of one program
5	essential importance	Experience and judgment shows strongly in favor of one program
7	strong importance	The facts show strongly in favor of one program
9	extreme importance	Full evidence shows absolutely in favor of one program
2,4,6,8	intermediate values	Between the explanations above

Source: revised from Saaty, 2001, p. 26.

Step 5 - Create a pairwise comparison matrix: After creating the assessment model architecture diagram, start to calculate the relevant importance of different level's evaluation factors as shown in Figure 5.

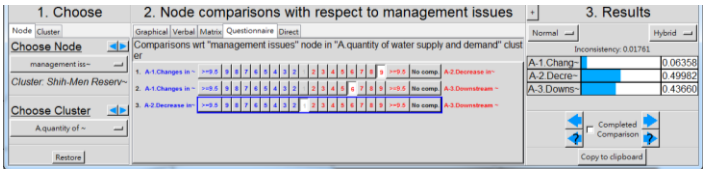

Figure 5. Establishment of pairwise comparison of matrices (using SuperDecisions ™ software)

Step 6- Obtain a pairwise comparison matrix feature vector and the maximize eigenvalue: After obtaining the pairwise comparison matrix , use the eigenvalue method normally used in data analysis to obtain the feature vector and the maximum eigenvalue. In the procedure, obtain the last level's feature vector and then turn down, and finally obtain the maximum eigenvalue overall which means the priority of the lowest level's backup plan to the highest goal.

Step 7 - Consistence test: The pairwise comparison matrix needs to pass the consistence test. The consistence test is based on the consistence ratio of the pairwise comparison matrix to proceed. CR=CI/RI which CI means consistence index and RI means random index. Consistence index CI=λmax/n-1 and RI is based on the level number n of the

pairwise comparison matrix. When CR≤0.1 it means the evaluation number has consistence and is acceptable.

Step 8 - Choose the fittest plan: After performing the steps above, obtain different evaluation standards and the priority number of the plans. The larger the numbers, the higher the priority for the acceptance of the plan.

In summary, the fittest plan chosen through the Analytic Network Process not only considers the dependent problems existing between the plans and standards, but also fits the determined goals.

4. Data/model analysis

In the ANP method, each aspect of evaluation, influencing factors and alternative programs are independent but have the property of mutual influence (Saaty, 2001). This study took the mutually influencing relationship between every criteria (A-E), 13 factors (A1, A2…E2, E3), and program (alternative 1-8) to construct a map of the relationship network of the ANP as shown in Table 3 & Figure 6 .

When considering the example of management of preservation sites, based on investigative results (Table 5), respondents believe that "national land planning" is most important in comparison with other aspects with an estimated importance ratio of 28.33%. The second most important aspect is "soil and water preservation", at a ratio of 23.56%, while having "supply and demand of water" and "maintenance of water quality" at 22.39% and 17.76% respectively. The ANP survey results all show that of 13 reservoir catchment preservation management influencing factors, the top five relatively important factors are: "intensity of land usage", "collapse of sloping fields", "decline of reservoir capacity", "environment and geological properties" and "downstream water requirements". Furthermore, respondents believe that the impact of "land usage intensity" and "collapse of sloping fields" are most significant, at ratios of 19.03% and 16.72% respectively (Figure 6). Statistics and analyzed results of the 8 alternative programs show that respondents believe "participation of people" to be the primary concern in future management strategies, at 27.40%. Regarding land usage and development, the second concern was to conduct a complete "review of the impact of development of soil and water resources on the environment", at a ratio of 18.20%. The third was "the construction of information management platforms and benefit analysis", at a ratio of 13.92%; the fourth was "water environment monitoring", at 13.76%; and the fifth was "surface environment monitoring system", at 10.29% (Figure7).

Table 5
ANP final investigative results (by 9 policy stakeholders)

Criteria	Normalized ratio	Factors	Normalized ratio	Alternatives	Normalized ratio
A.	0.223850667	A-1	0.039009292	1. Post-exploitation environment impact analysis	0.1819701
		A-2	0.095333226		
		A-3	0.089508141	2. Ground surface monitoring system	0.102935
B.	0.177465	B-1	0.066628759		
		B-2	0.082405215	3. Water environment monitoring	0.1376381
		B-3	0.028431028	4. Reduction of pollution and improvement measures	0.0926468
C.	0.235567444	C-1	0.167162434		
		C-2	0.06840501	5. Water supply potential and demand assessment	0.0260503
D.	0.283278667	D-1	0.092976636		
		D-2	0.190302031	6. Landside control	0.0455706
E.	0.079838111	E-1	0.018315917	7. Information platform settlement and value-added data analysis	0.1391923
		E-2	0.024730024		
		E-3	0.036792118	8. Public participation	0.2739964

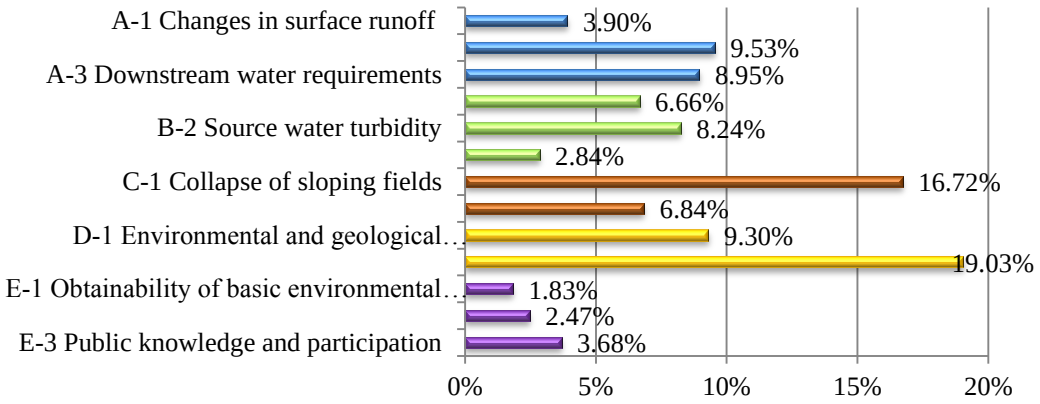

Figure 6. ANP investigative results of the 13 factors

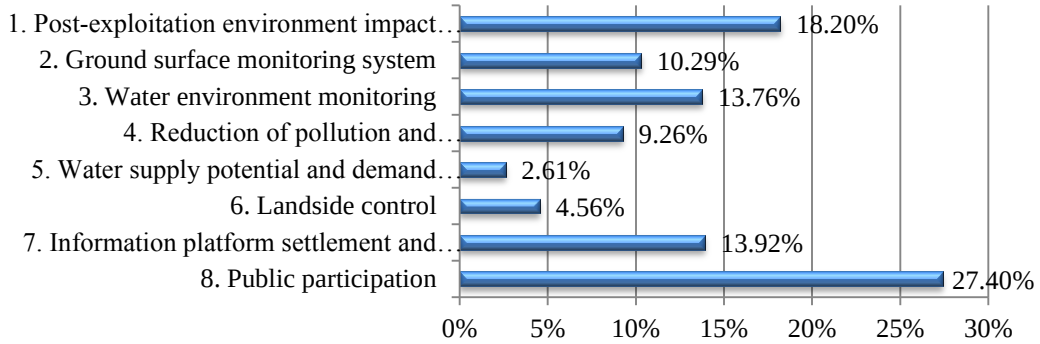

Figure 7. ANP investigative results of the 8 alternative programs

5. Limitations

This research used the Shimen Reservoir's water preservation area as the research site. However, due to limited interview subjects, compilation of documents and related arrangement of conditions, it might not be suitable for other Taiwanese catchments, but can be of general reference and utility, collaborative planning, and multiple criteria strategizing for reservoir catchments of similar environments to implement in the future.

6. Conclusions

This paper utilized the perspective of collaborative planning of stakeholders for investigation. The ANP survey results showed that "national land planning" is the primary problem that needs to be resolved for the Shimen Reservoir, and its main influencing factor originates from "the extent of land use". Secondly, "water and soil conservation" is an issue that needs to be of increasing concern, and management strategies should be developed for its main influence factor, "collapse of sloping fields". In regards to alternative programs for the management of catchment preservations, respondents believe "public participation" should be of main concern for the management strategies of future water catchment preservation sites. They also believe that promoting application of management strategies such as "post-exploitation environment impact analysis" and "information platform settlement and value-added data analysis" would strengthen the result of future planning of water source preservation areas, environmental impact analysis and further follow-up of investigations and management.

Based on the above, we know "land planning" is the primary processing task of the Shimen catchment area. In fact, the most efficient fundamental control method is land planning for unpredictable weather disasters. Land planning is not only reasonable development, distribution and use of the land, but is also a system including values, law regime, practices and executive management. Although the Taiwanese Interior department proposed the idea, the execution schedule of the land planning law still got postponed. Based on this action, the management of Shimen catchment area will not be acted upon completely, but will slowly change due to the environmental need for survival and weather change. Thus, this study promotes three suggestions according to the primary strategy of future management which is 'public participation'.

6.1 Realize the importance of local people participating in catchment area protection

In recent years, the conservation experience of catchment areas inside the country makes us slowly realize that 'people' are the most important lesson. The prerequisite to conserving the catchment area based on people is to fully communicate with local people and attempt to combine the awareness of the risk of disaster prevention with local people's power. With the evolution of time, group trust starts to be a potential expectation asset and helps the group to solve the common problems with cooperation and coordination. (Kramer, Brewer and Hanna, 1996)

6.2 Catchment protection area should establish autonomous public participation mechanisms

Any system's change involves social, ecological and economic factors and becomes a complex and dependent process. Therefore, it is hard to use the linear model to explain its causality, not to mention to predict the results. Facing this unchangeable fact, the first

priority is to enhance the adapting ability of the system with the help of policy tools. We can only overcome the unpredictable effect from trial and error by increasing adapting ability. In other words, 'collect and archive the environmental basic information' should be the basis of managing catchment conservation areas. They cannot be efficiently managed without a full information data base. This suggests that we should keep promoting the development of environmental survey and monitoring technology, enhancing the information collecting ability, increasing real-time monitoring effectiveness and establishing the early warning system to continue to reinforce incomplete basic monitoring information. However, technology has always been people-oriented so incorporating autonomous public participation mechanisms, such as water conservation volunteers, will become the main development of in-situ information built and real-time early warning reporting function.

6.3 The catchment area's governance should continue to communicate with local people

Commitment is the most basic requirement for joint action. Learning how to set up the interacting platform, combine participants different views, establish the basis of consensus, coordinate the policy tools, and execute is the way to solve differences and produce complementary roles. This could include (1) willingness to compromise and have a cooperative attitude for the policy results, (2) collecting related knowledge to fit an uncertain environment, and overcoming the dilemma together, (3) combining all the necessary information in such a way to reach the policy goals (Giacchino and Kakabasdse, 2003). Once participants have adequate policy commitment, the 'supportive context[2]' will help the decisions to combine economy, society and environment and have adequate ability to adapt in order to efficiently respond to unpredictable impacts (Meadowcroft, 2005). Thus, we suggest that the catchment area should maintain the operation of a cross-border coordination platform and include the stakeholders, especially the local people, in the policy consultation process so that the best solution to solve the hard problems of the catchment area can be developed.

In summary, since in the same situation everyone's frame view varies, it is obvious that their way of handling problem would vary as well. Therefore, based on the feasibility of the policy, this study suggests that the government should expand the level of participation and combine local people's opinions into the policy-making process even when the value and goals are in conflict. If the policy process is inclusive, it will be easier to obtain policy legitimacy and to combine the local information more efficiently to manage the local catchment area together.

[2] The so-called supportive context means all kinds of information from the environment, including the assistance of people, tools, system or devices offered by the work place or the group. Because it is considered to be proper in our culture, it can help to accomplish the individual work result.

REFERENCES

Chiou, C. T. (2013). *Public Policy.* 4th ed. Taipei: Guliu.

Freeman, R. E. (1984). *Strategic management: A stakeholder approach.* New York: Cambridge University Press.

Giacchino, S., and S. Kakabadse. (2003). Successful policy implementation: The route to building self-confident government. *International Review of Administrative Science 69(2),* 139-160.

Healey, P. (2006). *Collaborative planning, Second edition: Shaping places in fragmented societies.* London: Palgrave Macmillan.

Huang, H. F., Chen, H. C., and S. Liu. (2014). Management strategies for Taiwan reservoir catchment areas: A case study in SHIH-MEN reservoir catchment area, *Proceedings of the International Symposium on the Analytic Hierarchy Process:13th ISAHP conference,* Washington DC, 254-255.

Koppenjan, J. F. M., and E. H. Klijn. (2004). *Managing uncertainties in networks.* New York: Routledge.

Kramer, R. M., M. B. Brewer, and B. A. Hanna. (1996). Collective trust and collective action: The decision to trust as a social decision. In R. M. Kramer and T. R. Tyler (Eds.), *Trust in organizations: Frontiers of theory and research,* 357-389. Thousand Oaks, CA: Sage Publications.

Lin, S. P. (2011). *An analysis of the public management.* Taipei: Wunan.

Meadowcroft, J. (1997). Planning, democracy and sustainable development. *International Political Science Review 18(2),* 167-189.

Meadowcroft, J., K. N. Farrell, and J. Spangenberg. (2005). Developing a framework for sustainability governance in the European Union. *International Journal of Sustainable Development, 8(1/2),* 3-11.

Mitchell, R. K., Agle, B. R. & Wood, D. J. (1997). Toward a theory of stakeholder identification and salience: the principle of who and what really counts. *Academy of Management Review, 22(4),* 853–886.

Ostrom, E. (2007). Institutional rational choice: An assessment of the institutional analysis and the development framework. In P. A. Sabatier (Ed). *Theories of the policy process,* 21-64. Boulder, CO: Westview.

Ostrom, E. (1999). Coping with tragedies of the commons. *Annual Review of Political Science 2,* 493-535.

Patton, C. & D. Sawwicki, (1986). *Basic models of policy analysis.* Englewood Cliffs, NJ: Prentice-Hall.

Saaty, T. L. & Saaty, R. W. (2003). *Decision making in complex environments (AHP & ANP), Super Decisions.*

Seldtani, K., & I. Takahashi (2001). A unified model and analysis for AHP and ANP. *Journal of Operations Research Society of Japan, 44(1),* 67-89.

Stone, D. A. (2002). *Policy paradox: The art of political decision making*. New York: W. W. Norton & Co.

Thomas L. Saaty, (2001). *Decision making with dependence and feedback: The Analytic Network Process*. Pittsburgh: RWS Publications.

Water Resources Agency, Ministry of Economic Affairs, R.O.C (2009a). *Strategic Planning of Water Quality Management within Shihmen Reservoir Catchment.*

Water Resources Agency, Ministry of Economic Affairs, R.O.C (2009b). *Strategic Planning of Management Techniques for Water Quality and Quantity Protection Areas (1/2).*

Wu, D. (2008). *A dictionary of public policy*. Taipei: Wunan.