How Experts’ Opinions and Knowledge Affect Their Willingness to Pay for and Ranking of Hydrological Ecosystem Services

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Abstract: To ensure that ecosystem services are included in decision-making processes, many studies have relied on expert opinions and knowledge to identify, rank, and assess willingness to pay. In this study, expert opinions according to their expertise in hydrology, ecology, and sociology were surveyed and compared in terms of (1) recognition and ranking of hydrological ecosystem services (HESs) and (2) willingness to pay for HESs. The decision-making process was also investigated, specifically the rankings of factors in experts’ plans for climate change adaptation. The experts’ recognition of and opinions concerning HESs were positively correlated at various levels with intention to pay (i.e., whether respondents were willing to pay for HESs). Most experts recognized the importance of HESs and allocated high average scores of 9.15, 8.17, and 8.41 to water yield, sediment export, and nutrient export, respectively, using a scale from 1 (least important) to 10 (most important). The percentage of sociologists (100%) exhibited greater intention to pay than those of hydrologists (70%) and ecologists (93%), respectively. Experts prioritized environmental impact over economic cost in policy decision-making, and they differed significantly by field in terms of their rankings of the functional, economic, environmental, and social considerations of decision-making. The results revealed significant differences among experts in their decision-making preferences according to their fields of knowledge. The experts of a specific study field may be more willing to pay for that than for another. Greater intellectual exchange and analysis among experts should be implemented and diverse expert opinions should be solicited in policy decision-making.

Keywords: ecosystem services; willingness to pay; expert knowledge; prioritization

1. Introduction

Nature increases human well-being, and healthy Hydrological Ecosystem Services (HESs) are a noteworthy provider of crucial ecosystem services (ES) [1,2]. These services have long been taken for granted and empirical evidence has demonstrated the finite nature of these ecosystem services. Human action and climate change have diminished or even eliminated ecosystem services. Climate change is undoubtedly a major challenge for humanity, and people are increasingly focused on the sustainability and availability of natural resources [3,4]. Some studies have argued that economic development is a major driver of the deterioration of ecosystem services [5], suggesting that economic growth should be balanced with the protection of ecosystem services [6,7].

All aspects of policy-making must include ecosystem impact assessments, and the maintenance of ecosystem sustainability should be the primary principle that guides decision-making [7,8]. Globally, most people agree that sustainability must be incorporated into policy goals, but the implementation of this principle has been suboptimal. This is attributable to governments’ prioritization of the budget and
Studies have used various methods to quantify the value of ecosystem services and natural resources. These methods include the contingent valuation method, travel cost analysis, production functions, dose–response modeling, energy analysis, the hedonic price method, and the System of Environmental Economic Accounting: Experimental Ecosystem Accounting. Over the past decade, numerous studies have relied on expert opinions and knowledge to identify and rank ecosystem services. It is useful by using the contingent valuation method (CVM) to quantify willingness to pay (WTP) for assessing ES values. Subjective values have been measured mostly by using questionnaires, and statistical analyses have been used to investigate respondents’ intention to pay (i.e., whether they were willing to pay for environmental services), their willingness to pay (WTP), payments for environmental services, and various causal relationships. However, expert opinions may not have an empirical, quantitative, or scientific basis; moreover, they are unreliable and may result in misestimation in ecosystem service studies. Expert-based ecosystem service scores might be subjective and unreliable. The integration into policy making of expert opinions may enhance ecosystem service operations. The uncertainty of expert judgments has been analyzed in studies on ecosystem services. However, expert opinions depend on the field of expertise and can be subjective depending on the type of ecosystem service that is being referred to and should be carefully measured and assessed. Accordingly, this study also conducted a survey to realize experts’ preferences for decision-making, which is helpful for more cautious processing of incorporating expert opinions into decision-making.

Much of the literature on the quantification of the value of ecosystem services has been produced lately. As the literature matures, research that is sensitive to local contexts is required to deepen discussions. Moreover, the identification of ecosystem services is essential to ensure that decision-makers prioritize specific services for protection. Ali et al. indicated that water quality was the most valuable and the highest willingness to pay in their study watershed. This study extended the finding of Peng et al. that adaptation plans are required to address the effects of climate change on hydrological ecosystem services (HESs) in the Chinan catchment of eastern Taiwan. Specifically, the present study used a questionnaire to gather data on individual backgrounds, user feedback, and how much respondents were willing to pay to maintain current HESs to determine the value that experts from certain fields attribute to HESs. Differences in opinion and judgments were evaluated in an analysis of variance (ANOVA). These data were used to identify correlations between each factor and WTP. Our results can facilitate the understanding of the tendency of experts to the value of HESs, such as water yield, sediment export, and nutrient export. The results also indicated that experts in various fields had different priorities in decision-making; this can inform the comprehensive planning of decision-making models for HESs.

2. Materials and Methods

2.1. Questionnaire Design and Data Collection

In this study, we hypothesized that the hydrologists may have different opinions and ranking on HESs compared with ecologists and sociologists. Peng et al. predicted that climate change will increase the average monthly water yield by up to 45% or reduce it by up to 88% from the base period (1996–2009); this indicates a wide range of fluctuation. The study site was in eastern Taiwan (Figure 1). Furthermore, although the average annual water yield will increase in terms of
total volume, it will be concentrated in the wet seasons. Peng et al. [45] also concluded that (1) the average annual sediment yield will increase by more than 50% relative to the base period and will be concentrated in June to October and that (2) changes in nutrient export (of nitrogen and phosphorus) will decrease, but their monthly averages will fluctuate more. According to these findings, water yield in the Chinan catchment (Figure 1) will be concentrated in wet seasons as a result of climate change, and this increased water yield will accelerate soil erosion and adversely affect ecosystem services. Furthermore, increased monthly fluctuations in ecosystem services will destabilize ecosystem services in the region. Therefore, to guarantee basic and stable ecosystem services in the face of climate change, the present study focused on the Chinan catchment and surveyed how much experts were willing to pay to maintain the area’s ecosystem services. As in the study of Castro et al. [20], we had no contact with the experts participating in the survey. The questionnaire was designed with reference to other ecosystem questionnaires based on the CVM [20,46], as presented in the Supplementary Materials S1. The preliminary questionnaire was then revised and finalized after expert consultations, group discussions, and a pilot test. The questionnaire contained an introduction and four sections. The introduction explained the research background to ensure that participants understood the harmful effects of climate change on ecosystem services in the region. The research architecture diagram is presented in Figure S1 (see Supplementary for details).

The first section of the questionnaire collected data on participants’ individual backgrounds, namely their gender, age, number of family members, income, and place of residence. The second section was used to analyze the relevance of the research topic to the respondents; it gathered data on the respondents’ interest level in the research site, knowledge level on ecosystem services, and engagement level in research related to ecosystem services and water resources. Respondents were asked to rate each item on a 5-point scale. They were also asked to rate the importance of water yield, sediment export, and nutrient export from 1 (least important) to 10 (most important) to obtain the perceived importance of ecosystem services.
The third section focused on respondents’ intention to pay and WTP to maintain ecosystem services. Intention to pay for the services was measured on a 5-point scale with the following responses: very willing, willing, neutral, unwilling, and very unwilling. WTP was used to measure changes in the monetary valuation of benefits provided by ecosystem services and to investigate the maximum amount that respondents are willing to pay to retain these benefits [47]. In the present study, the respondents selected the annual amount they would be willing to pay (in NTD) for the three ecosystem services from among seven price ranges: 0, 1–99, 100–499, 500–999, 1000–2999, 3000–4999, and ≥5000. Experts were asked to rate the importance of each ecosystem service and select the price range in which their WTP fell. On the basis of these responses, each variable could be parsed, analyzed, and bias mitigated [35,48].

Section four assessed how the expert respondents prioritized the following considerations when deciding on water resource adaptation plans in response to climate change: (1) the ability of ecosystem services to accommodate human needs (functional aspect), (2) the economic cost of investment in ecosystem services (economic aspect), (3) ecological or environmental impact (environmental aspect), and (4) acceptance by the general public (social aspect).

2.2. Sampling and Statistical Analysis

To obtain the opinions of experts and scholars, respondents were recruited from universities across Taiwan. The sample included experts who study ecosystem services. Respondents were randomly selected and included professors, associate professors, or assistant professors who were equally likely to be experts in hydrology, ecology, or sociology. In total, 65 experts were identified as prospective respondents, including 20 in hydrology, 22 in ecology, and 23 in sociology. The experts were from 16 public universities, three private universities, and Academia Sinica. Of the 65 targeted experts, 48 responded to our invitation to participate, but two submitted incomplete questionnaires, resulting in valid questionnaire responses from 46 experts (15 in hydrology, 15 in ecology, and 16 in sociology) for analysis.

The statistical analyses of the questionnaire data were done by using SPSS software (version 17.0). The questionnaire contained variables in four aspects. First, a correlation test ($p < 0.05$) of the questionnaire data was conducted. Variables passing the correlation test were then subjected to a chi-square test of independence to determine interdependence among them. The chi-square test was conducted for the dependent variables of gender, income, place of residence, participation in related research, and field of expertise and for the independent variables of recognition of ecosystem service importance, importance scores, intention to pay, and WTP. Subsequently, a one-way independent ANOVA was conducted to identify significant differences among the groups’ mean values. A post hoc test [49] and multiple comparisons were then conducted to identify pairs of groups that differed significantly from each other. A cross-comparison table was generated to analyze differences and correlations between variables and determine whether the experts’ identities, professional experiences, and fields of expertise affected their intentions to pay, WTP, and rankings of various considerations in decision-making.

2.3. Contingent Valuation Method

In the contingent valuation method (CVM), respondents are directly asked how much money they are willing to pay or accept in exchange for gaining or losing an environmental function improvement or resource protection measure [13]. CVM is widely used to assess the nonmarket value of natural resources [50]. The present study employed the most widely used indices in CVM, namely WTP and willingness to accept, to qualitatively realize the level of payment amount for experts in different fields.

Because most ecosystem services have nonmarket benefits, a hypothetical market for ecosystem services as commodities must first be established [48]. On the basis of this hypothetical market, CVM elicits the respondent’s WTP for environmental resources; WTP is the basis for evaluating the value of environmental resources. The value of ecosystem services can be effectively obtained
through the elimination of specific bias and proper questionnaire design [14]. Many studies have used WTP surveys to investigate the value and necessity of maintaining biodiversity, forest ecosystems, ecosystem services, water resources, and water quality [17,51–53]. By using intention to pay and WTP as contingent valuation indices, this study employed the payment card approach to assess the WTP of respondents. Specifically, various price ranges were presented to respondents, who were then asked to select the range representing the price they were willing to pay. If the researcher ensures equal class intervals for all options, this method can be used to prevent starting point bias, as well as refusals to answer caused by an open-ended question [54–56].

2.4. Ordinal Position Value Method

Multiple-criteria decision-making (MCDM) can involve the scientific selection of the most appropriate criterion or the ranking of multiple criteria in various schemes when multiple criteria or goals must be considered in a decision-making process [57,58]. The major function of MCDM is to assist decision-makers in weighing tradeoffs to select the optimal decision. MCDM involves many analytical methods, one of which is the ordinal position value method [59], which is used to determine the most suitable scheme through rankings alone. This method is based on an allocated performance value for each scheme that is subject to various criteria; the performance values for the criteria are arranged in a performance matrix, and the most appropriate scheme is then identified through comparison. For instance, scheme X is in the first ordinal position on the basis of criterion A; schemes Y and Z are in the first and second ordinal positions, respectively, on the basis of criterion B. If criterion A is considered to have greater importance, the performance value of scheme X is higher than that of scheme Y. Therefore, scheme Y is placed one ordinal place behind scheme X, and scheme Z is placed two places behind scheme X. With this rule, the ordinal positions and priority levels of every scheme can be determined on the basis of the importance of multiple criteria [59]. The present study used the importance assigned by experts in each field for the ordinal position of each decision consideration. The Friedman test is a nonparametric (distribution-free) test that can be used for ranked data within each treatment group [60,61]. This study used the Friedman test to assess the ordinal positions of the four functions, such as function, economy, environment, and social, from experts. This method yielded the total value of the ordinal positions and priority rankings for all considerations.

3. Results

3.1. Correlations and Differences

A chi-square test was performed to analyze the correlation between gender and the independent variables (Tables S1 and S2). Significant correlations were noted between gender and agreement with the importance of HESs and between gender and intention to pay ($p < 0.05$). Although our questionnaire design did not account for gender, a majority of female respondents (73%) exhibited high intention to pay (very willing); by contrast, 29% of male respondents provided the same response. Most female respondents agreed with the importance of ecosystem services (93% selected strongly agree), whereas only 61% of male respondents provided the same response. The importance of HESs differed significantly for male and female respondents.

Field of expertise was then used as the dependent variable, and a chi-square test was employed to assess the correlation between field of expertise and the independent variables (Tables S3 and S4). Field of expertise was significantly correlated with knowledge of HESs and with agreement on the importance of HESs. The importance of HESs differed significantly among experts in the three fields.

3.2. Differences among Experts by Field of Expertise

An ANOVA was used to analyze differences between field of expertise and other independent variables. Differences were detected among the fields of expertise in terms of knowledge regarding HESs, agreement with the importance of HESs, participation in research on ecosystem services,
and intention to pay (Tables S5 and S6). Between-group differences were also analyzed: hydrology and ecology experts differed significantly in their knowledge regarding HESs, their agreement level regarding the importance of these services, and their participation in research on ecosystem services; and hydrology and sociology experts differed significantly in their participation in ecosystem service research and their intention to pay.

### 3.3. Knowledge Regarding HESs

The ANOVA post hoc test indicated that experts from various fields differed significantly in WTP and HES-related decision-making (Tables 1 and 2). Participation in research related to ecosystem services did not affect their perception of the importance of HESs. Experts who had participated in research related to HESs assigned average scores of 9.13, 8.28, and 8.41 out of 10 to water yield, sediment export, and nutrient export, respectively, whereas experts who had not participated in such research assigned average scores of 9.29, 7.57, and 8.43, respectively (Table S7). Experts who had participated in research on water resources rated the importance of HESs slightly higher than did those who had not participated in such research, but no significant difference was observed. The average scores for water yield, sediment export, and nutrient export were 9.24, 8.59, and 8.53, respectively, among experts who had participated in research on water resources and 9.10, 7.93, and 8.34, respectively, among experts who had not participated in such research.

| Table 1. ANOVA results by expert field of knowledge. |
|-----------------------------------------------------|
| **Differences of Average Knowledge Scores**          |
|                                                     |
|                                                     |
| **Between**                                         |
| **Hydrologists and**                                |
| **Ecologists**                                       |
| **Between**                                         |
| **Hydrologists and**                                |
| **Sociologists**                                     |
| **Between**                                         |
| **Ecologists and**                                  |
| **Sociologists**                                     |
| **Order of**                                         |
| **Average Scores**                                  |
|                                                     |
| Level of knowledge of ecosystem services             | 0.667 * | 0.5 | −0.167 |
|                                                     | hydrologists > sociologists > ecologists |
| Agreement with the importance of hydrological ecosystem services | 0.467 * | 0.413 | −0.054 |
|                                                     | hydrologists > sociologists > ecologists |
| Participated in ecological service projects          | 1.067 * | 1.063 * | −0.004 |
|                                                     | hydrologists > sociologists > ecologists |

Note: The ANOVA post hoc test yielded statistically significant differences in WTP and decision-making for HESs among experts from various fields. *: statistical significance level: 0.05.

| Table 2. Expert intention to pay and willingness to pay (WTP). |
|---------------------------------------------------------------|
| **Average Ranking of Intention to Pay**                       |
| **WTP for Different Sectors**                                 |
| **(SNT/Year)**                                                |
| **Water**                                                     |
| **Sediment**                                                 |
| **Nutrient**                                                  |
| **Export**                                                    |
| **Export**                                                    |
| **Export**                                                    |
| Participated in ecological service-related research projects  | Yes | 4.28 | 1506 | 1456 | 1501 |
| Participated in water resource related research projects      | Yes | 4.24 | 1476 | 1521 | 1491 |
| Participated in ecological service-related research projects  | No  | 3.71 | 1800 | 1379 | 1700 |
| Participated in water resource related research projects      | No  | 4.17 | 1595 | 1400 | 1555 |
research. Experts who had participated in related projects exhibited greater intention to pay because of their increased engagement and familiarity with the subject.

Whether an expert had participated in related research did not significantly affect their WTP for ecosystem services. However, experts who had participated in related research exhibited a similar WTP across the three ecosystem services; they also demonstrated a greater recognition of the importance of sediment export for soil strength maintenance. Experts who had not participated in related research were willing to pay a higher price only for water yield and nutrient export.

### 3.4. Intention to Pay and WTP

Of the 46 respondents, 42 (91.3%) expressed an intention to pay to maintain at least one of the HESs. Experts in various fields of expertise differed significantly in their intentions to pay; 70.34% of hydrology experts reported an intention to pay, in contrast to the 93.33% and 100% of ecology and sociology experts, respectively, who reported intentions to pay. To further investigate differences in intention to pay among experts in the three fields, intention to pay was converted into scores ranging from 1 (least willing) to 5 (most willing; Figure 2). Hydrology, ecology, and sociology experts had average intention scores of 3.73, 4.27, and 4.63 points, respectively. Sociology experts expressed the highest intention to pay.

![Figure 2. Intention to pay to maintain ecosystem services ranked from 1 (most willing) to 5 (least willing) by field of expertise.](image)

We used the median values from WTP class intervals, namely NT$50, NT$300, NT$750, NT$2000, and NT$5500 to further analyze how much experts from each field were willing to pay for various ecosystem services (Figure 3). For water yield, the average WTP values among hydrologists, ecologists, and sociologists were NT$1150, NT$1607, and NT$1806, respectively. For sediment export, these values were NT$1347, NT$1503, and NT$1431, respectively. For nutrient export, these values were NT$1550, NT$1806, and NT$1500, respectively.

Many ecology-related WTP surveys have indicated that wealthy people are more willing to pay to protect ecosystem services [62–66] and the environment, which is reasonable. However, the present study identified no significant effect of income on intention to pay. However, this result can be attributed to the respondents being scholars; their incomes were high, and even respondents whose income levels were less than NT$100,000 monthly, based on the standard salary for college and university educators, did not earn much less than NT$100,000 (Figure 4). Therefore, the respondents’ incomes were similar, and they were wealthier than the average person in the general population.
Figure 3. Average WTP to maintain the three ecosystem services among all respondents (black) and experts in hydrology (blue), ecology (green), and sociology (yellow).

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Figure 4. Intention to pay by monthly income level. Data were collected from 36 respondents (those who did not disclose their incomes were excluded). Respondents rated intention to pay ratings as very willing, willing, or neutral. None of the respondents selected unwilling or very unwilling.

3.5. Prioritizations and Decision-Making Considerations

In the questionnaire, expert respondents assigned scores of 1 (low importance) to 10 (high importance) to water yield (water resource supply), sediment export (soil strength maintenance), and nutrient export (water quality maintenance; Table 3). The total scores for these ecosystem services were 421 for water yield, 376 for sediment export, and 387 for nutrient export.

Slight differences were detected among the distributions of importance scores for water yield, sediment export, and nutrient export awarded by experts in hydrology, ecology, and sociology (Figure 5). Compared with experts in the other two fields, hydrology experts assigned lower scores to water yield. However, they assigned similar scores to all HESs, whereas experts in the other two fields assigned the highest scores to water yield.
When asked which factor should be considered first in decision-making for climate change adaptation plans, 41.3% of respondents selected the ability of ecosystem services to accommodate human needs, 2.17% selected the economic cost of investments in ecosystem protection, 50% selected ecological or environmental impact, and 6.52% selected the level of acceptance among the general public (Table 4).

**Table 3.** Importance scores for hydrological ecosystem services (HESs) assigned by respondents from various fields.

|                | Water Yield | Sediment Export | Nutrient Export |
|----------------|-------------|-----------------|-----------------|
| Total score    | 421         | 376             | 387             |
| Fields         |             |                 |                 |
| Hydrology      | 134         | 125             | 133             |
| Ecology        | 141         | 126             | 122             |
| Sociology      | 146         | 125             | 132             |
| Average score  | 9.15        | 8.17            | 8.41            |

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**Figure 5.** Importance scores from low (1) to high (10) for water yield, sediment export, and nutrient export by field of expertise.

**Table 4.** Proportions of expert rankings for decision-making considerations.

| Factors    | Ordinal Position | 1st     | 2nd     | 3rd     | 4th     |
|------------|------------------|---------|---------|---------|---------|
| Functional| 1st               | 41.30%  | 34.78%  | 13.04%  | 10.87%  |
| Economic  | 2nd               | 2.17%   | 19.57%  | 32.61%  | 45.65%  |
| Environmental | 3rd            | 50.00%  | 36.96%  | 8.70%   | 4.35%   |
| Social    | 4th               | 6.52%   | 8.70%   | 45.65%  | 39.13%  |

Note: The first and fourth ordinal positions indicate the highest and lowest priority, respectively.

By referring to the ranking evaluation method based on ranking, the sum of ordinal positions from first through fourth for each decision-making considered was calculated. The lowest ordinal total was defined as having the highest priority in the selection process (Table 5). Environmental impact was the highest-priority decision-making consideration with an ordinal total of 77, followed by the ability of ecosystem services to accommodate human needs with an ordinal total of 89. The third
consideration was social acceptance with an ordinal total of 146, and the fourth consideration was economic cost with an ordinal total of 148. Table 5 presents these results.

| All Respondents | Hydrology Experts | Ecology Experts | Sociology Experts |
|-----------------|-------------------|-----------------|-------------------|
| Functional      | 89                | 31              | 27                | 31                |
| Economic        | 148               | 48              | 44                | 56                |
| Environmental   | 77                | 28              | 28                | 21                |
| Social          | 146               | 43              | 51                | 52                |

Note: Lower ordinal total scores indicate higher priority.

As indicated in Table 4, economic cost was ranked the least important (i.e., fourth) decision-making consideration on average. Therefore, when economic factors were ranked in third place, the factor that was ranked fourth was considered less important relative to economic factors. In total, 15 experts ranked economic factors in third place, and among them, 14 ranked social factors in fourth place and one ranked ecosystem function in fourth place. Social factors were ranked in the second to last place. A total of 21 experts ranked social factors in third place; among them, 16 ranked economic factors in fourth place, four ranked functional factors in fourth place, and one ranked environmental factors in fourth place.

As presented in Table 4, experts largely believed that environmental factors should be prioritized in decision-making. Therefore, experts who ranked environmental factors as the second priority believed that the factors they ranked first were more crucial. A total of 17 experts ranked environmental factors as second; among them, 16 ranked functional factors as first, and one ranked social factors as first. Functional factors were ranked the second most important on average; 16 experts ranked functional factors second, of whom 14 ranked environmental factors first and two ranked social factors first.

The ordinal position value method [59], and the selection of importance weights based on experts’ rankings revealed that economic and social factors were the least important. When these factors were ranked in the third ordinal position, the factor in the fourth position (perceived to be the least important) decreased in importance, increasing its ordinal total. When either environmental or functional factors—which were ranked as highest-priority considerations—were ranked in second, the factor in the first ordinal position (considered to be most important) increased in importance, reducing its ordinal total. The ordinal total value for each consideration was derived using this principle, and the difference in priority ranking became more prominent, as presented in Figure 6.

Figure 6. Rankings for each consideration; differences in rankings were more evident when the ordinal position value method was used.
The Friedman test indicated that the environmental aspect of decision-making differed significantly from the economic and social aspects (see Table S8). The functional aspect differed significantly from the economic and social aspects. Figure 7 presents the ES function, cost, environmental impact, and social acceptability rankings. The priority levels assigned to the considerations differed greatly according to the respondents’ fields of expertise. Environmental impact was ranked as the first and second priority by 68.75% and 31.25% of the sociology experts, respectively. Most of the hydrology and sociology experts designated economic factors as the lowest priority, whereas some ecology experts (26.67%) ranked economic factors as the lowest priority. A majority of ecology experts believed that acceptance by the general public was the least important factor in decision-making.

Figure 7. Number of experts ranking the ability of ecosystem services to accommodate human needs, economic cost of investment in ecosystem protection, environmental impact, and social acceptability according to field of expertise (1 and 4 indicate highest and lowest priority, respectively).

4. Discussion

4.1. Relationship of Field of Expertise with Recognition of the Importance of Ecosystem Services and Intention to Pay

Although our experimental design did not account for gender, 73% of female respondents expressed a high intention to pay; this was more than twice the 29% of male respondents providing this response. The ratio of female population is 46% in the study area. This indicates that women are willing to contribute more to maintain ecosystem services than are men [67]. Furthermore, an overwhelming majority (93%) of female respondents strongly agreed that ecosystem services are crucial; this finding is consistent with other empirical findings that WTP is strongly correlated with the level of recognition of environmental items [14,25,68–71]. Expert-based approaches rely strongly on experts’ experience, knowledge and attitudes [24,37]. The characteristics and the preferences of respondents in social and economic backgrounds majorly influence the WTP for ecosystem services [16]. Jaligot et al. [72] classified stakeholders’ perceptions of the importance of ES before planning. Therefore, eliciting expert knowledge as carefully and scientifically as possible is essential, but this process is not straightforward [42]. The first step of the matrix approach is expert selection. Our selection criteria were similar to those used in the study of Campagne et al. [73]. Moreover, our study assessed the opinions and knowledge of experts in various biophysical and social fields. Jacobs et al. [37] indicated that diversity of fields increases confidence in expert judgments because of their professional and motivational backgrounds, skills, experience, authority within their field, and local knowledge [37]. To supplement missing data from questionnaire responses and identify the associated factors of human perceptions in
cultural ecosystem services, Dou et al. [21] relied on 16 expert interviews. We selected experts who were professionals in their fields and had relevant HES experience. No significant differences were noted in their recognition of the importance of HESs, which they rated highly. These high ratings were consistent with other studies’ findings that relative to the general public, experts are more likely to recognize the importance of and be willing to protect ecosystem services [67]; in particular, only water supply functions were recognized by the average member of the public as a crucial ecosystem service [17,20]. Expert knowledge was an essential source of studying in a previous study using the matrix model [37]. In the present study, experts’ knowledge was assessed. In this study’s survey on the importance of water yield, sediment export, and nutrient export, hydrology experts rated the three ecosystem services as equally important rather than rating water yield more highly. This may have occurred because hydrology experts have superior knowledge of the relationship of sediment and nutrient exports with water quality maintenance and soil and water conservation. By recognizing the relationships among soil, sediment, and nutrients, hydrologists were more likely to rate all three services equally. In summary, the knowledge and opinions of experts affect their perceptions of the importance of ecosystem services. Involvement in ecological service assessments is a fundamental role of experts [37]. Our study indicated that recognition of HESs did not differ significantly between experts with and without experience in relevant research on ecosystem services. However, decision makers usually rely on the opinions of fields of experts for decision-making. Our results further indicated that experts from various fields have same opinions about the importance of HESs, but difference still can be identified in willingness of payment for and opinions to make decision due their knowledge. Thus, to formulate the comprehensive adaptation plans, decision-making should involve a wide range of experts.

4.2. Necessity of Ecosystem Service Maintenance

In this study, a majority of experts expressed a high intention to pay for ecosystem service maintenance. All the surveyed sociology experts expressed such intentions. Regarding WTP, most experts were willing to pay higher prices to maintain water yield; this finding is consistent with those of previous studies [17,20]. However, respondents indicated a WTP of approximately NT$1500 per year to maintain all three ecosystem services, indicating that ecosystem services have value in terms of human well-being. Therefore, ecosystem service maintenance is a necessary goal for humankind. Previous studies have indicated that income positively influences WTP [17,74]. However, no significant effect of income on WTP was detected in the present study; this may have occurred because the experts in our study had similar incomes.

Experts’ knowledge influences their scores, rankings, and evaluation of ecosystem services [17,23,37,42]. Respondents with different fields of expertise expressed varying opinions in the present study. Sociology experts exhibited significantly greater intention to pay (intention to pay score: 4.63) than did hydrology experts (intention to pay score: 3.73). This finding is attributable to sociologists’ tendency to emphasize public affairs. In the present study, experts in hydrology had a relatively low WTP to maintain water yield compared with experts in other fields, despite hydrology experts’ perception of water yield as crucial. This indicates that a lower WTP does not necessarily indicate lower recognition of an ecosystem service’s importance. Regarding the similar prices that hydrology experts were willing to pay for all three ecosystem services, we noted that hydrology experts did not favor water yield maintenance and that they perceived water yield, sediment export, and nutrient export as equally crucial. Furthermore, most hydrology experts in Taiwan are likely to believe that the core problem affecting water resources in Taiwan is not water shortages but water retention. Their greater knowledge of methods for maintaining this ecosystem service makes them less likely to perceive that the problem warrants only financial solutions. Please refer to the Table S9 for respondents’ explanations regarding their unwillingness to pay.
4.3. Professional Biases in Decision-Making

Of the experts, 50% designated environmental impact as the highest priority, and 46% designated economic cost as the lowest priority. This indicates a consensus (among nearly half of the experts across the three fields) that mitigating ecological harm and protecting ecosystem services should be prioritized in plans for climate change adaptation. Differences in priority became more evident when considerations were ranked using the ordinal position value method: environmental impact (ordinal position of 64) was prioritized over economic cost (ordinal position of 164).

It is essential to integrate ES and ES preferences into decision-making for environmental planning and management [28,35,72]. Providing decision-makers with information on ecosystem services is essential for encouraging decisions that promote human well-being [16,75]. The prioritization of ecosystem services by various communities may result in different decisions regarding their protection [11,16,20]. In the present study, decision-making considerations differed greatly by field of expertise. In particular, sociologists prioritized environmental impact, and more than half the hydrologists and sociologists ranked economic cost as the lowest priority. Castro et al. [20] indicated that 96% of their study’s respondents prioritized environmental benefit, which was the highest-priority decision-making factor. However, only 27% of ecology experts ranked economic cost as the lowest priority, and 60% ranked social acceptance as the lowest priority. Other studies have focused on surveying expert opinions or comparing expert and public opinions rather than comparing scholarly fields of expertise [17,46,67]. These differences in preference are likely related to research participants’ backgrounds and disputes regarding water use and conservation among expert groups [20].

This study’s findings indicate that field of expertise exerts major effects on decision-making. Thus, to formulate comprehensive adaptation plans, decision-making should involve a wide range of experts [76]. The present study’s inclusion of experts in hydrology, ecology, and sociology demonstrated that the consultation of experts from various professional backgrounds reduces information uncertainty in the final results and can clarify the perception of residents [21,26]. Our analytical method can be used to evaluate experimental designs before resident or stakeholder surveys of diverse resident or stakeholder groups. Previous studies have used various sample sizes in their expert surveys, such as 8-11 expert participants by Ahlheim et al. [77], 41 national experts by Markantonis and Bithas [78], 20 respondents by Bhandari et al. [17], 11 respondents by Dou et al. [21], 24 experts by Qu et al. [26], and 8 experts as a group by Hynes and O’Donoghue [79]. The use of experts in CVM studies was discussed by Haab et al. [80] since it may be difficult to include suitable numbers of experts in general population samples. Our study was based on 46 expert surveys, and we analyzed scores, rankings, and evaluations of ecosystem services in the real case. This study focuses on representative expert surveys who have studied relevant researches in HESs, and compares the degree of acceptance and willingness to pay for the experts in different fields. However, sample size of experts should be analyzed in future studies. Moreover, sample size should be large enough, if studies base on CVM for representative of general population.

CVM or a choice experiment (CE) is widely utilized in WTP estimates and influence of various factors on WTP [81–83]. CE approach generates choice scenarios presented to the participants to make their choices from among the scenarios in a choice set, during the data collection process [81–83]. Although CVM and conjoint analysis have been applied in WTP estimates [84–87], conjoint analysis in WTP estimates sometimes have shown biased upwards that should be carefully interpreted [88]. Finally, a CVM allows the estimation of average willingness to pay through a regression analysis which also helps measure the preferences of individual respondents [28,33,35,43,81], but our study focuses on experts and groups in various fields. The regression analysis is an approach in further study of WTP on general population or households and preferences of individual respondents.

5. Conclusions

Experts with a comprehensive understanding of ecosystem services attributed higher functional value to them and subsequently expressed a stronger intention to pay for their maintenance. Few of
relevant studies systematically have worked on the variate of expert opinions from various fields relevant to ecosystem services. A majority of the surveyed experts prioritized ecological considerations when selecting adaptation plans and actions by decision makers for climate change. This study designed questionnaire including both WTP and ranking options. It is resulted that the experts from different fields had various options, which is subject to the knowledge type of ecosystem service. The various options are being referred to and should be carefully measured and assessed for different focuses of ecosystem services. This result indicates a high level of consensus with regard to maintaining ecosystem services among scholars in Taiwan who have similar fields of expertise. However, this consensus has not been incorporated into decision-making among Taiwanese policy-makers. This study demonstrated that experts’ perceptions differ according to their field of expertise. These differences affect experts’ opinions. Environmental experts often engage in environmental policy-making; although such experts recognize that ecosystem services are crucial, experts in various subfields prioritize considered factors differently. Policies may neglect crucial facets of an environmental challenge if insufficiently diverse expert opinions are obtained. Therefore, a wide range of experts should be consulted to improve policies. Their knowledge and expertise can serve as a starting point for ecosystem service assessments, which can be followed up with additional data for further assessment. The aforementioned problems that emerge in the evaluation of ecosystem services may benefit decision-makers in multidimensional watershed management. Our approach strategy can be further applied to evaluate the opinions from experts in the process of decision-making on the selection of adaptation plans.

Supplementary Materials: The following are available online at http://www.mdpi.com/2071-1050/12/23/10055/s1, S1. Questionnaire on the value of ecosystem services in Chinan Catchment, Hualien (experts). S2. Chi-square test results for gender with various independent variables. S3. Chi-square test results for field of expertise with various independent variables. S4. ANOVA results for experts’ understanding of ecosystem services. S5. Average importance score for experts. S6. Friedman test results. S7. The reasons of unwillingness to pay. S8. Research architecture diagram.

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