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Hydrology and Earth System Sciences Discussions

Interactive comment on "A social-economic-engineering combined framework for decision making in water resources planning" *by* E. S. Chung and K. S. Lee

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We like to thanks Christofides (Referee) for this helpful and constructive comments on the submitted manuscript. We acknowledge the suggestions for improving the paper, which will be integrated in the upcoming revised manuscript.

General comments

Referee: As far as I understand, the authors have made a study of the Anyangcheon River, trying to answer the question of how it would be better to spend a given amount of money for environmental protection related to the river. I say "as far as I understand" because the presented material is difficult to follow, and I find myself confused. Part of

the confusion is because of carelessness on behalf of the authors related to usage of certain terms, but I think that there is a more general problem: the authors attempt to present a "new methodology" and then they present the application of the methodology to Anyangcheon as a case study. The presentation of methodology is thus made on a too abstract level, without any examples, and is very difficult to grasp. It might be better if, instead, they talked about Anyangcheon straight from the beginning, explaining exactly what the problems are before explaining how they go on to solve them. I will illustrate the difficulties with some examples from the abstract."; AC: We rewrite our paper as you recommended. 1. Abstract was totally revised, 2. Section 3 was removed and we add the important statements into Section 4 -7, 3. Description of choice experiment was totally changed in my own expression, 4. We added other references (Chung and Lee, 2009a; 2009b) to make this article understood well. Two new references were just published and online-published. 5. The description of AEI to consider residents opinions was deleted for simplicity.

Referee: "The abstract begins by saying that the study presents a methodology for, among other things, evaluation of willingness-to-pay for the ";improvement of hydrological vulnerability". Later on, it says that "the hydrological vulnerability consists of potential streamflow depletion (PSD) and potential water quality deterioration (PWQD)."The phrase "improvement of hydrological vulnerability" does not make any sense. "Reducing the hydrological risk"; might be better." AC: We totally revised the abstract in order to reflect your comments. The revised abstract follows: "This study presents a social-economic-engineering combined framework for decision making in water resources planning. This framework consists of four parts which are to spatially identify the grades on hydrological vulnerability using multi-criteria decision making (MCDM) techniques and pressure-state-response model, to evaluate the monetary values of improvement on hydrological vulnerability grade using choice experiment method, to derive an alternative evaluation index (AEI) to quantify the effectiveness of all alternatives using MCDM techniques and driver-pressure-state-impact-response model, and to combine the derived willingness-to-pays (WTPs) with the AEI and do the cost-benefit

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analysis of feasible alternatives. This framework includes the stakeholder participation in order to quantify the preferences with regard to management objectives and WTPs of alternatives. Finally, the economic values of each alternative can be estimated by this study which combines the WTPs for improvements on hydrologic vulnerability grade with the AEI. This social-economic-engineering combined framework can provide the decision makers and stakeholders with more specific information as well as decrease the uncertainty of the cost-benefit analysis."

Referee: The next period is even more confusing: "PSD and PWQD not only provide survey respondents with sufficient site-specific information to avoid scope sensitivity in a choice experiment but also support the standard of dividing the study watershed into six sub-regions for site-fitted management." I cannot understand how a potential risk can provide someone with information, nor how a potential risk cab divide a region in six sub-regions, or how a potential risk can "support the standard" of making such a division, or what kind of standard such a division can be. Furthermore, until this point, the authors have not mentioned the Anyangcheon River, but are only describing a "new methodology". Therefore, is the number "six" significant is this new methodology and would apply to any kind of watershed? If yes, why? AC: "Six" is not proper expression. We deleted the obscure sentences. Furthermore, we totally revised the abstract in order to reflect your comments.

Referee: This is almost half the abstract. The rest of the abstract does not make any more sense. Maybe this is because the first half of the abstract has not successfully created the necessary context. I don't know. AC: We totally revised the abstract in order to reflect your comments.

Referee: The main text of the paper is better than the abstract, but it is still problematic. In Section "Specific comments" below, I give some specific comments, but they should be treated as examples of why the text is incomprehensible rather than as problems that would solve the problem if corrected. The paper should be totally revised, resubmitted and re-examined, because the substance can not be assessed as it is. AC: We

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rewrite our paper as you recommended.

Specific comments

Referee: In 2918/6, "the studies or models are about stakeholders": what does this mean? AC: Since it's not a good expression, we deleted it.

Referee: In 2819/27: "From these reasons": what reasons? AC: "these reason" means the previous four things. But we changed this obscure phrase into "Therefore".

Referee: In 2920, 4-9: what does this paragraph mean? AC: We deleted this paragraph because of its ambiguousness.

Referee: In 2932/11: it is claimed that "the structure of the selected criteria is shown in Fig. 2" and the caption of Fig. 2 talks about "indices" What are the criteria and what are the indices in Fig. 2? AC: Indices are PSD and PWQD. We deleted Fig. 2 and explained the structure in the text.

Referee: Elsewhere the text talks about "indicators" is "indicators" and "criteria" the same thing, as implied in 2839/6? AC: "criteria" is the same to "indices&".

Referee: What is the parameter b in the Table 1? AC: "b" means the balancing factor of composite programming. But, we changed the method (composite programming -> weighted summation method). The composite programming of b = 1 is the weighted summation method. All relevant phrase and sentences were revised.

Referee: In 2833/9, "The attributes should be selected", what attributes are we talking about? AC: 'attributes' means general attributes of CEM in this sentence. Therefore we added the next phrase in front of the previous sentence as follows: "In the choice experiment method"

Referee: In 2833/19, it says that the attributes were selected from "components that represent PSD and PWQD" but Table 2 implies that PSD and PWQD are the attributes. AC: We revised the whole sentence as follows: "In this study, PSD and PWQD were

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the attributes."

Referee: In 2934/18, What is 'SAS Macro OPTEX' and 'D-efficiency design' AC: SAS provides a set of macros for designing experiments analyzing choice data. PROC OPTEX will optimize designs based on the factors specified, levels of factors and model statement. We added the statement in the text. D-efficiency design means the design technique based on D-optimal criteria for non-linear models in a choice experiment context. D-optimality is related to the covariance matrix of the K-parameters. We added the explanation of 'SAS MACRO OPTEX', but deleted 'D-efficiency design' in the text since its description would be long and out of this article. We totally revised the text as follows: "This study used the orthogonal main effects design which is effective in terms of isolating the effects of individual attributes on the choice. The ability to 'design in' this orthogonality is an important is an important advantage over the revealed preference random utility models, where attributes in reality are often found to be highly correlated with one another (Hanley et al., 1998; Yoo et al., 2008). The orthogonal main effects design was implemented by using the SAS Macro PROC OPTEX procedure. SAS Macro PROC OPTEX usually optimizes designs based on the factors specified, levels of factors and model statements."

Referee: In 2834/19, What is meant by 'orthogonal design' AC: Experimental design is concerned with how to create the choice sets in an efficient way, i.e. how to combine attribute levels into profiles of alternatives and profiles into choice sets. The standard approach is orthogonal designs, where the variations of the attributes of the alternatives are uncorrelated in all choice sets. We added the description of orthogonal design as the above answer.

Referee: In 2837/4, What are the "two indices"? AC: It means PSD and PWQD. We substituted "two indices" into "PSD and PWQD".

Referee: In 2838, What is a_i in Eq. 8? AC: We added the following explanation after Eq. 8: "a_i means the ith feasible alternative"

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Referee: In 2939/1, Why is j termed 'effectiveness'? AC: We revised it as follows:"j means the objectives of management"

Referee: Another problem is the quotation of Yoo et al. (2008) following 2824/25. The authors have copied verbatim a large part (about one HESSD page) of Yoo et al. (2008). Although they do mention that they did so, the part copied should be inside quotes or indented, so that one can see immediately what the copied part is. (In addition, for copying such a large part, I think that they need to obtain permission from the publisher; a practice with which I disagree for scientific literature, but it is the law) AC: We just picked up the description of random utility function among papers on choice experiment. But since it would be a problem, we revised that part on the whole as follows:

2.3. Random utility model

The choice experiment approach was initially developed by Louviere and Hensher (1982) and Louviere and Woodworth (1983). Choice experiments share a common theoretical framework with dichotomous-choice contingent valuation in the Random Utility Model (McFadden, 1973), as well as a common basis of empirical analysis in limited dependent variable econometrics (Greene, 2002). According to this framework, the direct utility function for each respondent, x, can be decomposed into two parts: a deterministic element (Z), which is typically specified as a linear index of the attributes (X) of the i different alternatives in the choice set, and a stochastic element (e), which represents unobservable influences on individual choice. This is shown in equation (1): Equation (1) is shown in the revised article. Thus, the probability that any particular respondent prefers option g in the choice set to any alternative option h can be expressed as the probability that the utility associated with option g exceeds that associated with all other options, as stated in equation (2): Equation (2) is shown in the revised article. In order to derive an explicit expression for this probability, it is necessary to know the distribution of the error terms (e_ij). A typical assumption is that they are independently and identically distributed with an extreme-value (Weibull) distribution: Equation (3)is

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shown in the revised article. The above distribution of the error term implies that the probability of any particular alternative g being chosen as the most preferred can be expressed in terms of the logistic distribution (McFadden, 1973), stated in equation (4). This specification is known as the conditional logit model: Equation (4) is shown in the revised article. where nu is the scale parameter that is inversely proportional to the standard deviation of the error distribution. This parameter cannot be separately identified and is therefore typically assumed to be one. An important implication of this specification is that selections from the choice set must obey the independence from the irrelevant alternatives (IIA) property, which states that the relative probabilities of two options being selected are unaffected by the introduction or removal of other alternatives. This property follows from the independence of the Weibull error terms across the different options contained in the choice set.

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