Reference Number: hess-2013-575

RESPONSES TO REVIEWER ONE'S COMMENTS

We are grateful to Reviewer #1 for his/her helpful and insightful comments. The provided comments have contributed substantially to improving the manuscript. Accordingly, we have made significant efforts to revise the manuscript, with the details being explained as follows.

Point #1

COMMENT: *Details need to be specified about how to mitigate non-point pollution in the case study?*

RESPONSE: We much appreciate the reviewer's helpful comment. Accordingly, we have added more explanations as follows:

> Increasing population, diminishing supplies and changing climatic conditions amplify difficulties in resolving the conflicts between human activities and environment. Since agriculture is one of the most important water users, the farmland use arrangement can directly or indirectly influence the water resources utilization and environment. Specifically, the abuse of fertilizer and pesticide, can cause extensive anthropogenic non-point source pollution. Conversely, the water pollution control can also exert an impact on associated human activities, such as water allocation and cultivation. These all call for the need to integrate pollution mitigation efforts into the framework of water resources management.

Point #2

COMMENT: *The title of constraint 5, i.e. Environment Constraints, should be replaced by another one that could precisely express the meanings of constraint 5.*

RESPONSE: We are appreciative of the reviewer's suggestion. According to the reviewer's comments, we have specified Equation 6s as "Non-point pollution control constraints".

Point #3

COMMENT: *Table 7 contains the information about the interaction over consecutive planning periods, including the available water resources, confidence levels, and inexact allocation schemes. These were not provided in Results Analysis.*

RESPONSE: We much appreciate the reviewer's helpful suggestion, and have updated the corresponding paragraph as follows:

> In this research, four p_i values are defined, including 0.01, 0.05, 0.10, and 0.15. Generally, a higher p_i value indicates a higher probability of constraint violation, resulting in a larger volume of water supplies and a higher system benefit. As shown in Table 7, the quantity from surface drainage water in period 1 would be [20.73, 21.54], [21.07, 21.96], [21.25, 22.18], and [21.37, 22.24] million m^3 under a p_i level of 0.01, 0.05, 0.10, and 0.15, respectively. The corresponding volume of groundwater would be [28.33, 29.14], [28.69, 29.62], [28.87, 29.88], and [29, 30.05] million m^3. Similarly, when the p_i value changes from 0.01 to 0.15, the amount of river water would increase from [102.79, 107.79] to [104.61, 109.38] million m^3. From periods 1 to 3, a downward trend would be observed for the amounts of water supplied. For example, under a p_i level of 0.01, the amount of groundwater would be [28.33, 29.14], [26.52, 27.61], and [21.91, 24.16] million m^3 in periods 1 to 3, respectively. Such a decrease is probably contributed by the advancement of water-saving techniques and the improved efficiency in water utilization.

Point #4

COMMENT: *What are the data sources in tables 1 and 2?*

RESPONSE: We are grateful for the reviewer's insightful and helpful comment. Accordingly, we have added the reference to table 1 and 2, as well as the cited reference in the revised manuscript.

Table 1. Benefits of water supply for end-users ($\$/m^3$)

End-user	Period $t = 1$	$t = 2$	$t = 3$
Metallurgical	[27.57, 29.56]	[25.53, 27.31]	[23.77, 24.67]
Food industry	[14.86, 15.09]	[14.29, 14.45]	[13.64, 13.77]
Tourism	[9.11, 9.25]	[8.76, 8.86]	[8.36, 8.44]
Household	[14.26, 25.3]	[31.95, 43.42]	[44.77, 45.48]

Data Source: Dong et al., 2013

Table 2. Costs for pumping and delivering water resources ($\$/m^3$)

Water resource type	Period $t = 1$	$t = 2$	$t = 3$
Surface drainage	[0.0033, 0.0034]	[0.0032, 0.0033]	[0.0031, 0.0032]
Groundwater	[0.0056, 0.0062]	[0.0054, 0.0059]	[0.0052, 0.0057]
River water	[0.0062, 0.0063]	[0.0060, 0.0061]	[0.0058, 0.0059]

Data Source: Dong et al., 2013

Dong, C., Huang, G. H, Tan, Q., and Cai Y. P.: Coupled planning of water resources and agricultural land-use based on an inexact-stochastic programming model. Front. Earth Sci., 8(1), 70-80, 2014.

Point #5

COMMENT: *The sentence "the solutions obtained from ICCP and DIFSP will be compared to demonstrate the application of this developed method for supporting the* *planning of water and farmland use system" on page 5 should be polished in terms of grammar, logic, and terminology.*

RESPONSE: We much appreciate the reviewer's helpful suggestion, and have revised this sentence to "the solutions obtained through the existing ICCP method and the DIFSP approach proposed in this study will be compared to demonstrate how DIFSP would get improved upon ICCP in the planning of water and farmland use system".

Point #6

COMMENT: *It was stated on page 10 that "the dynamics of the water resource and agricultural land use management system makes it critical to clarify the interactions between various components and those intimately involved in the planning process". Could authors provide more details about "dynamics" and "interactions". Corresponding examples in real cases would be much helpful for readers.*

RESPONSE: We fully agree with the reviewer's comment. Accordingly, we have briefly explains this as follows:

> However, in real world problems, various components in the water resource and agricultural land use management system impact each other, which inevitably leads to complexities and dynamics. For example, the interactions between population and water supplies can directly cause complex water utilization among various end-users. This makes it critical to clarify the interactions among system factors and those intimately involved in the planning process (Chung et al., 2008).

Point #7

COMMENT: *I am confused about the statement "Depending upon the use pattern, surface water can be sent directly to consumers or through a water treatment plant" on* *page 11. What is a use pattern in real-world water resources allocation systems? Why is there a difference between supply processes of surface water? What are the driving forces for such a difference?*

RESPONSE: We much appreciate the reviewer's careful review. In general, 'use pattern' indicated in the original manuscript referred to different intended uses of water resources. According to the reviewer's helpful comments, we have revised this sentence as follows:

> Depending upon different intended uses for end users, surface water can be sent directly for industrial production and irrigation, or should be treated prior to drinking and other uses.

Point #8

COMMENT: *What are potential limitations of the developed method? Could it be reliable for any real case of water resources and farmland systems management?*

RESPONSE: We are grateful to the reviewer for his/her concerns. The developed DIFSP method can be effective and reliable for addressing real-world problems of water resources and farmland management systems, as it is capable of tackling the highly uncertain parameters that are common in those systems and pose challenges to the related decision-making processes. However, successful application of the developed method relies on the screening and adoption of practical approach as well as the accessibility of sufficient samples for obtaining the distribution information of lower and upper bounds of RBIs.

Generally, we are deeply grateful to Reviewer #1 for his/her insight and careful review. His/her comments have greatly helped improve the paper.

Reference Number: hess-2013-575

RESPONSES TO REVIEWER TWO'S COMMENTS

We are grateful to Reviewer #2 for his/her insightful comments. The provided comments have contributed substantially to improving the manuscript. Accordingly, we have made significant efforts to revise the manuscript, with the details being explained as follows.

Point #1

COMMENT: *Many abbreviations in Introduction are unnecessary since they are not referenced in the followings.*

RESPONSE: We much appreciate the reviewer's suggestion. Accordingly, we have removed some abbreviations in the revised manuscript:

> Previously, a plenty of modeling technologies were applied into water resources and farmland use system planning with non-point sources pollution mitigation (Satti et al., 2004; Chen et al., 2005; Riquelme and Ramos, 2005; Victoria et al., 2005; Kondilia and Kaldellis, 2006; Gregory et al., 2006; Khare et al., 2007; Castelletti et al., 2008; Qin et al., 2011; Mahmoud et al., 2011; Zarghami and Hajykazemian, 2013; Canter et al., 2014). For example, Satti et al. (2004) used the GIS-based water resources and agricultural permitting and planning system to simulate the effect of climate, soil, and crop parameters on crop irrigation requirements. Chen et al. (2005) established force-state-response (DSR) dynamic strategy planning procedure to assist responsible authorities in obtaining alternatives of sustainable top river basin land use management. Riquelme and Ramos (2005) built up a Geographic Information System (GIS) on vine growing for supporting decision making

> processes related to land and water management in Castilla-La Mancha, Spain. Victoria et al. (2005) adopted modeling tools, ISAREG model and SAGBAH model, to solve multi-scale problems with irrigation water uses and non-point source pollution in basins. Qin et al. (2011) proposed a system dynamics and water environmental model to operate the integrated socio-economic and water management system in a rapidly urbanizing catchment. Mehta et al. (2013) developed integrated water resources management models using the water evaluation and planning decision support system, for three towns in the Lake Victoria region. Zarghami and Hajykazemian (2013) proposed a new optimization algorithm by coupling the mutation process to the particle swarm optimization, which was successfully applied to an urban water resources management with non-point sources pollution problem for Tabriz, Iran.

Point #2

COMMENT: *Specific examples to explain uncertain system components in various forms such as RBIs and intervals might be helpful for readers to understand the connection between developed models and real-world problems.*

RESPONSE: We are appreciative of the reviewer's insightful comment. Accordingly, we have expanded the last paragraph in section 3.1 as follows:

> Therefore, several optimization technologies will be introduced to handle these uncertainties in this system. For example, economic coefficients (e.g., unit benefit of water supply and pollutants treatment cost), technologies efficiencies, and continuous variables can be expressed as interval numbers. Given the random and dynamic features of water resources availabilities (i.e., surface drainage water, ground and river water), it is rather hard to accurately determine their two bounds. And the random boundary interval (RBI) will be adapted to reflect their dual uncertainty, with the lower and upper bounds of RBI being continuous random variables. Then the developed dual-inexact fuzzy stochastic programming (DIFSP) method will be applied into a water and farmland use planning model (WFUPM) with non-point sources pollution mitigation.

Point #3

COMMENT: *(Line 5 on page 6): Should FBI be replaced by RBI? What does IFLP stand for? What is the origin of lamda?*

RESPONSE: We much appreciate the reviewer's helpful suggestion, and have this sentence as follows:

> Then RBI can be incorporated into the interval fuzzy linear programming (IFLP) model through the introduction of membership grade λ (Cao et al., 2010):

Point #4

COMMENT: *Long sentences should be separated into short ones in technical writing, e.g.line 10 on page 9 and line 22 on page 11.*

RESPONSE: We are grateful for the reviewer's insightful and helpful comment. Accordingly, we have revised these two sentences as follows:

> Among these two submodels, f^+ and f^- correspond to the lower and upper bounds of the objective function values. When the objective function is to be minimized, sub-model corresponding to f^- is firstly formulated. And then the sub-model corresponding to f^+ can be obtained based on the solution of the first sub-model.

> With the consideration of these elements, water and farmland use planning model (WFUPM) with non-point sources pollution can be formulated. Its objective is to maximize the total system benefit, covering benefit for agriculture irrigation, water supply benefits for industry, tourism, residents, and minus the costs for water pumping and delivering, as well as wastewater treatment. Specific as follows:

Point #5

COMMENT: *(Line 11 on page 10): Should it be "with non-point sources pollution control/mitigation"? What do future system changes mean?*

RESPONSE: We much appreciate the reviewer's helpful suggestion, and have revised this sentence to "These all call for the need to integrate pollution mitigation efforts into the framework of water resources management.".

Point #6

COMMENT: *(Line 9 on page 16): What is the meaning of total quantity control? How are RBIs combined with water resources availability?*

RESPONSE: We fully agree with the reviewer's comment. Accordingly, we have revised the sentence "Finally, the total quantity control should be applied to the non-point sources pollutions (i.e., nitrogen and phosphorus)." to "Finally, the total quantity control should be applied to control the discharge amount of non-point sources pollutions (i.e., nitrogen and phosphorus).". Besides, we have revised "And the random boundary interval (RBI) will be adapted to reflect the dual uncertainty of water resources availability, with the lower and upper bounds of RBI being continuous random variables." to "Given the random and dynamic features of water resources availabilities (i.e., surface drainage water, ground and river water), it is rather hard to accurately determine their two bounds. And the random boundary interval (RBI) will be adapted to reflect their dual uncertainty, with the lower and upper bounds of RBI being continuous random variables.".

Point #7

COMMENT: *(Line 18 on page 17): An alternative expression for authors' consideration is "from [?, ?] in period 1, through [?, ?] in period 2, to [?, ?] in period 3".*

RESPONSE: We much appreciate the reviewer's careful review. Accordingly, we have revised this sentence to "As the tourism develops, it would consume rather large a proportion of water usage, increasing from [14.26, 25.3] million m^3 in period 1, through [31.95, 43.42] million m^3 in period 2, to [44.77, 45.48] million m^3 in period 3, which should arouse the general concern of relevant department."

Point #8

COMMENT: *(Lines 6-9 on page 18): Why are upper bounds lower than corresponding lower bounds?*

RESPONSE: We much appreciate the reviewer's helpful suggestion, and have revised these lower and upper bounds in the revised manuscript.

> As shown in Table 7, the quantity from surface drainage water in period 1 would be [20.73, 21.54], [21.07, 21.96], [21.25, 22.18], and [21.37, 22.24] million m^3 under a p_i level of 0.01, 0.05, 0.10, and 0.15, respectively. The corresponding volume of groundwater would be [28.33, 29.14], [28.69, 29.62], [28.87, 29.88], and [29, 30.05] million m^3. Similarly, when the p_i value changes from 0.01 to 0.15, the amount of river water would increase from [102.79, 107.79] to [104.61, 109.38] million m^3.

Point #9

COMMENT: *(Pages 18-19): Revision suggestions: bigger –>higher, smaller –> lower, presents –> represents, and conversional –> conventional.*

RESPONSE: We agree with the reviewer' suggestion, and have corrected these words in the revised manuscript.

Point #10

COMMENT: *What are shortcomings of the developed method?*

RESPONSE: We appreciate the reviewer's insightful comment. The developed DIFSP method can be effective and reliable for addressing real-world problems of water resources and farmland management systems, as it is capable of tackling the highly uncertain parameters that are common in those systems and pose challenges to the related decision-making processes. However, successful application of the developed method relies on the screening and adoption of practical approach as well as the accessibility of sufficient samples for obtaining the distribution information of lower and upper bounds of RBIs.

Generally, we are deeply grateful to Reviewer #2 for his/her insight and careful review. His/her comments have greatly helped improve the paper.

Reference Number: hess-2013-575

RESPONSES TO REVIEWER THREE'S COMMENTS

We are grateful to Reviewer #3 for his/her helpful and insightful comments. The provided comments have contributed substantially to improving the manuscript. Accordingly, we have made significant efforts to revise the manuscript, with the details being explained as follows.

Point #1

COMMENT: *The future research needed to improve the DIFSP method should be mentioned in the conclusions.*

RESPONSE: We much appreciate the reviewer's helpful comment. Accordingly, we have added more explanations at the end of conclusions: In the future research, this developed DIFSP method can be applied to other environmental planning problems, and can be incorporated with other optimization technologies to handle various practical issues under uncertainty.

Point #2

COMMENT: *In the Results analysis, references for the WR-FUPM model should be provided. Is it the WFUPM mentioned in the Abstract? A short and genera introduction should also be added if possible.*

RESPONSE: We are appreciative of the reviewer's suggestion. According to the reviewer's comments, we have revised "water resources and farmland use planning model (WR-FUPM)" to "water and farmland use planning model (WFUPM)".

<u>Point #3</u>

COMMENT: *Advantage of the proposed method should be strengthened in the Abstract.*

RESPONSE: We much appreciate the reviewer's helpful suggestion, and have revised the abstract as follows:

> In this research, a dual-inexact fuzzy stochastic programming (DIFSP) method was developed for supporting the planning of water and farmland use management system considering the non-point source pollution mitigation under uncertainty. The random boundary interval (RBI) was incorporated into DIFSP through integrating fuzzy programming (FP) and chance-constrained programming (CCP) approaches within an interval linear programming (ILP) framework. This developed method could effectively tackle the uncertainties expressed as intervals and fuzzy sets. Moreover, the lower and upper bounds of RBI are continuous random variables, and the correlation exiting between the lower and upper bounds can be tackled in RBI through the joint probability distribution function. And thus the subjectivity of decision making is greatly reduced, enhancing the stability and robustness of obtained solutions. The proposed method was then applied to solve a water and farmland use planning model (WFUPM) with non-point source pollution. The generated results could provide decision makers with detailed water supply-demand schemes involving diversified water related activities under preferred satisfaction degrees. These useful solutions could allow more in-depth analyses of the trade-offs between human and environment, as well as those between system optimality and reliability. In addition, comparative analyses on the solutions obtained from ICCP (Interval chance-constraints programming) and DIFSP demonstrated the higher application of this developed approach for supporting the water and farmland use system planning.

Point #4

COMMENT: *Why is that only the effects of varied Pi values on the system benefit under upper bound were analyzed? How about that under lower bound?*

RESPONSE: We are grateful for the reviewer's insightful and helpful comment. Accordingly, the effects of varied P_i values on the system benefit under lower bound were reflected as the form of interval numbers, which display the same rule of upper bound.

Point #5

COMMENT: *Please update your references list by including more recent and relevant references. For example: (1) Z. Li et al, Inexact two-stage stochastic credibility constrained programming for water quality management, Resources, Conservation & Recycling (Elsevier), 73, 122-132 (2013). (2) F. A. Deviney Jr et al, Application to Threshold Violation in Water-Quality Indicators, Journal of Environmental Informatics, 19(2), 70-78 (2012)*

RESPONSE: We much appreciate the reviewer's helpful suggestion, and have these references in the revised manuscript as follows.

Li, Z., Huang, G., Zhang, Y. M., and Li, Y.P.: Inexact two-stage stochastic credibility constrained programming for water quality management, Resour. Conserv. Recycling, 73, 122-132, 2013.

Deviney Jr, F. A., Brown, D. E., and Rice, K. C.: Evaluation of Bayesian Estimation of a Hidden Continuous-Time Markov Chain Model with Application to Threshold Violation in Water-Quality Indicators, J. Environ. Inf., 19(2), 70-78, 2012.

Point #6

COMMENT: *There are still some minor syntax or grammatical mistakes. I would recommend proofreading it once again carefully to correct them.*

RESPONSE: We fully agree with the reviewer's comment. Accordingly, we have briefly explains this as follows:

(1) On page 989, "…which was successfully applied to an urban water resources management with non-point sources pollution problem for Tabriz, Iran." should be revised to "…which was successfully applied to the urban water resources management with non-point sources pollution problem for Tabriz, Iran.".

(2) On page 990, "These complexities lead to difficulties in solving the resulted uncertain optimization problems…" should be revised to "These complexities lead to the difficulties in solving the resulted uncertain optimization problems…", "Azaiez et al. (2005) tackled the uncertainties in the inflows through…" should be revised to "Azaiez et al. (2005) tackled the uncertainties in inflows through…", and "…few works were conducted to handle this type of uncertainties (dual uncertainty)…" should be "…few works were conducted to handle this type of uncertainty (dual uncertainty)…".

(3) On page 991, "Instead, the obtained data can be presented as random boundary interval (RBI) whose lower and upper bounds are random variables (Cao et al., 2010)." should be "Instead, the obtained data can be presented as random boundary interval (RBI) with its lower and upper bounds being random variables (Cao et al., 2010)."

(4) RBIs in the manuscript should all be revised to RBI.

(5) On page 995, "…it should be converted to linear or stepwise linear functions of λ in order to use the two-step method." should be revised to "…it should be converted to linear or stepwise linear functions of λ".

(6) On page 1005, "in tackling with the uncertainties (dual uncertainty)" should be "in tackling with the uncertainty (dual uncertainty)", and "a dual inexact fuzzy stochastic

programming (DIFSP)" should be "a dual-inexact fuzzy stochastic programming (DIFSP)".

Generally, we are deeply grateful to Reviewer #3 for his/her insight and careful review. His/her comments have greatly helped improve the paper.