Drink. Water Eng. Sci. Discuss., 5, C111–C114, 2012
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Drinking Water Engineering and Science Discussions

DWESD

5, C111–C114, 2012

Interactive Comment

Interactive comment on "Robust optimization methodologies for water supply systems design" *by* J. Marques et al.

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Received and published: 9 July 2012

We thank the Reviewer for the comments.

Comment 1.The Robust Model section includes a lot of equations with a lot of decision variables. This reviewer understands that the authors explained them all at the end of the section. But it might be clear to separate some of the equations into small groups, which will be easier for readers to follow. For example, the authors listed all of the constraints considered together. It might be better to separate the decision variables and constraints due to the formulation of the optimization problems from those ones due to the use of the optimization algorithm, such as YDd,i and Eq. (7).

Reply 1: We appreciate the comment and the robust model has been clarified on pages

4 and 5 of the attached paper.

Comment 2. Two minimum pressures are used in this study, which results in two different ways of penalizing a solution with constraint violation. However, it is not clear to this reviewer how these two different constraint violations are penalized. Especially for the first one, the authors only mentioned "the objective function is penalized".

Reply 2: the way the solutions are penalized is explained on pages 4 and 5 of the attached paper. Two minimum pressures are used in this study: desired pressures and the admissible pressures. Pressures can be lower than desired pressures but they have to be higher than the admissible pressures. If the nodal pressure stays between these values the objective function is penalized. The penalty is calculated for the nodes where pressure is lower than the desired pressure and is given by the difference between the minimum desired pressure for the node and the actual pressure in that node. All these differences are summed for all the nodes of the network and multiplied by a penalty coefficient for pressures that is a function of the level of robustness desired. In addition, if the pressure is lower than the desired nodal pressure the demand will not be totally satisfied, and the objective function is penalized as a function of the difference between the actual water demand and the demand that is effectively satisfied. To determine the quantity of water consumed in each node, a pressure-driven hydraulic simulator is used, where the consumption is a function of the pressure. All these differences are summed for all the nodes of the network and multiplied by a penalty coefficient for the demand that is a function of the level of robustness desired. After computing these terms, the penalty value is finally obtained as the sum of penalties of each scenario multiplied by a probability of that scenario occurring. Clearly, the higher this value the higher the cost of the solution, and therefore the minimization procedure will avoid the most expensive solutions.

Comment 3. Can the authors please explain why a minimum diameter for the pipes is used? Why not let the optimization algorithm to determine whether or not a smaller pipe diameter is required?

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Reply 3: A minimum pipe diameter constraint is used to ensure that we determine a looped network and a robust solution with alternative paths for the flow. If we don't use this constraint, the network solutions would be bound to have some nodes supplied only by a single pipe; this is not a good solution for a reliable design that requires alternative paths to supply consumers.

Comment 4. Can the authors please explain why two different maximum pressures are used? Is this realistic, considering the maximum pressure constraint is normally used to avoid damage to equipment or domestic appliances linked to the network?

Reply 4: The maximum pressures assumed in this study are presented on page 6 of the attached paper. They are limited and should not exceed 60 m for scenario 1 and 90 m for scenarios 2 to 7. We assume two different maximum pressures because customers should not have water supplied at uncomfortable pressures, in normal conditions; however in extreme situations, which occur sporadically and last a short time, the maximum pressures that the pipes and other devices have to withstand are higher. 90 m is the maximum pressure that will not damage the equipment.

Comment 5. In the second case, a pump is used. Can the authors please explain what type of pump is used (e.g. fixed speed pump or variable speed pump) and how it is sized in the problem?

Reply 5: This is a fixed speed pump and is designed with the elevation of the pump for scenarios 2 to 7 taken as decision variables. This information is given on page 7 of the attached paper. These variables can increase or decrease 1 m with the same probability during the optimization procedure.

Comment 6. For all of the solutions presented, there are some kind of constraint violations associated with them. Can the authors please explain why for both cases no feasible solutions without any constraint violation are found? Is this because the optimization has not converged?

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Reply 6: It is possible to determine solutions without any constraint violation. But this is not the objective of this work. If we increase the penalty coefficients then we can find solutions without any constraint violations. But this is the case of design for the worst case scenario, which sometimes has prohibitive cost increments, which should be avoided.

Please also note the supplement to this comment:
http://www.drink-water-eng-sci-discuss.net/5/C111/2012/dwesd-5-C111-2012-supplement.pdf

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Interactive comment on Drink. Water Eng. Sci. Discuss., 5, 173, 2012.

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