Hydrol. Earth Syst. Sci. Discuss., 6, C755–C759, 2009
www.hydrol-earth-syst-sci-discuss.net/6/C755/2009/

Hydrology and Earth System Sciences Discussions

HESSD

6, C755–C759, 2009

Interactive Comment

Interactive comment on "Agricultural-to-hydropower water transfers: sharing water and benefits in hydropower-irrigation systems" *by* A. Tilmant et al.

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Received and published: 18 May 2009

The authors would like to thank the reviewer for his thorough and meticulous review.

1.We attempted to condense the paper too much, to fit within what we understood to be the page limit. This resulted in inconsistencies and incomplete description of the model. The mathematical description of the model has been improved, and hopefully clearer now, within the limits of what can be achieved in a paper of reasonable length. Further detail may be found in various references provided.

2.We agree with the reviewer that irrigated agriculture is not a 100% consumptive use (return flows) nor is hydropower a 100% non-consumptive use (evaporation losses in the reservoir). As explained above, in our attempt to condense the paper, we over-simplified the description of the model. Actually, both irrigation returns flows (quantity and topology) and evaporation losses are considered. Section 2 has been revised but interested readers should refer to Tilmant et al. (2008) for a complete description of the SDDP algorithm.

3.The font used in HESSD was a source of confusion. As a matter of fact, from section three onwards, the same letter seems to have been assigned to two different variables: spillage losses denoted lt (twelfth letter of the alphabet) and the irrigation entitlement (water right) It (capital "i", ninth letter of the alphabet). With the font used in HESSD, lt and It look the same. To improve the clarity, the spillage losses are now denoted by the letter “p”.

2043/26. Fixed

2044/5. “...irrigation withdrawals are chosen so as to minimize the deviation from pre-defined target demands”

2044/15-18. Done. “Moving from a static to a dynamic allocation process in a fully-allocated basin implies that the policies are regularly updated according to the hydrologic status of the river basin. It also contributes to the development of river basin management strategies that increase the productivity of water”

2045/22. Done (chapter 8)

2046/9. Done

2046/17-18. Done

2046/19. We have left this as is, because we feel that the distinction is still valid even though irrigation is not fully consumptive and hydropower not fully non-consumptive. The point we want to make here is that downstream (essentially) non-consumptive users have an incentive to form a coalition to attract as much water as possible downstream. We believe that a heteroclite coalition involving farmers and power companies would not hold because both activities are essentially conflicting (orthogonal). Of course, both downstream farmers and power producers have a common interest in attracting as much water downstream, but as water keeps flowing downstream, their interests become divergent.

2047/15. Done

2047/25-15. rt (release) and It (water right) are now defined. Equation 2 is in a matrix form, i.e. one line per junction/node. Equation 2 is now extended to include the topology of irrigation return flows through a second connectivity matrix CI. The ordering was corrected.

2048/2. That paragraph was rewritten: “To incorporate irrigation net benefits into the objective function of SDDP, we need a new state variable that would indicate the status of the irrigation sector at any point in space and time. As explained in Tilmant et al. (2008), the new state variable, denoted yt, represents the total volume of water allocated to the crops from the beginning of the irrigation until current stage t. It is equivalent to a reservoir that would be refilled during the irrigation season with the irrigation withdrawals it, which are now decision variables, and that would be depleted when crops are harvested and sold. For notational simplicity, we assume maximum one irrigation demand site per abstraction point, but the model can handle as many "irrigation reservoirs" as the number of crops. “

2048/11. The net benefit function from irrigation is now denoted by “g”

2048/Eq. 7. For simplicity we assume one irrigation net benefit function per irrigation demand site, though the model can handle several crops per irrigation site, and also includes a relationship between crop yield deficit and irrigation supplies. In that case, each crop is represented by a state variable yt and is characterized by a specific planting date, harvest date, irrigation efficiency, farm-gate price, maximum irrigated area,

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variable costs and a yield reduction coefficient. In practice however, the full model has been rarely implemented due to the difficulty in gathering detailed agronomic data, and the increase in computation time when a large number of crops must be considered. In the Nile basin, for instance, the full model of the Nile/Blue Nile includes 16 storage reservoirs and 31 reservoirs of accumulated water for irrigation. To prevent extremes situations where we would, for example, under-irrigate or have a big single withdrawal to refill the "dummy" reservoir, the variables yt and it are constrained (upper and lower bounds). For example, pumping and/or conveyance capacities would not allow a single big irrigation withdrawal. However, we do assume that rationing, when it occurs, is evenly distributed over the irrigation season because of the storage capacity in the reservoirs.

2049/Eq 9. it is now on the right-hand side because it is a decision variable in the dynamic formulation (it is a parameter in the static formulation).

2050/Eq 13. Limits are imposed on "it" because it is a decision variable. Consequently, upper and lower bounds on conveyance capacity, pumping capacity, etc. must be taken into account.

2050/13&19. Done

2050/18. The productivity is the unit net benefit

2051/11. See our response to the main comment #3. pt = spills in time period t, whereas It = water right.

2051/14. allocations

2051/Eq 16. With the right symbols the equation is correct. The water transfer = It-it.

2053/20. Done

2055/21. You are right. Corrected

2056/5-9. See above. Water right (static)= It, allocation decision (dynamic) = it.

2057/7-8. Average ANNUAL contribution

2057/Eq 22. We agree. The equation was removed.

2062/Table 1. Done

2064/Table 3. “Average annual additional benefits (costs) with the dynamic approach [million US$]”

2067/Figure 2. Done

2069/Figure 4. The Y-axis are labeled “Non-exceedance probability (-)”. Figure caption =“Statistical distribution of the differences between dynamic and static annual benefits”.

Please also note the Supplement to this comment.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 2041, 2009.