Review of "Agricultural-to-hydropower water transfers: sharing water and benefits in hydropower – irrigation systems" by A. Tilmant, Q. Goor, and D. Pinte

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This manuscript presents an interesting hydro-economic analysis of agricultural and hydropower water uses in a system where the agricultural (consumptive) uses are upstream from the hydropower (non consumptive) uses. The analysis methods using Stochastic Dual Dynamic Programming and results for the cascade of reservoirs in the Euphrates river basin generally seem appropriate and should be of interest to HESS readers. However, the manuscript requires improvement in 3 general areas:

1. Inconsistencies and incomplete explanations in the mathematical notations should be corrected.
2. The presentation and treatment of irrigation water use as 100% consumptive and hydropower water use as 100% non-consumptive is not fully realistic. Irrigated agriculture is rarely 100% consumptive (deep percolation, drainage, runoff, salt leaching, etc.). Including the concept of "return flows" in the model formulation would make the formulation more general, applicable to other systems, plus identify further opportunities to share water and benefits between the two sectors.
3. At times, the writing and presentation is unclear and hinders understanding of the method or interpretation of the results.

Points #1 and #3 also prevent me from evaluating whether the model results are reasonable. Below, I provide annotated comments to further expand and elaborate on the above general points.

2043/26	Here and subsequently on 2045/22, 2046/6, etc., citations need to be enclosed in parenthesis.
2044/5	The word "distance" has an unclear meaning. Is this a physical distance or rather a deviation from predefined targets?
2044/15-18	Is a very long sentence that should be broken apart.
2045/22	It would also be appropriate to cite Fisher et al. (2005). *Liquid Assets*. Resources for the Future: Washington, D.C.
2046/9	Shorten to "… the difficulty to allocate water between downstream and upstream users is that the former rely on the latter through…"
2046/17-18	Awkward phrasing. Instead suggest, "the upstream user will have to pay to or receive from the downstream user compensation for the negative or positive externalities the upstream user generates downstream."
2046/19	Here the idea of "consumptive" and "non-consumptive" water users is introduced as though they are the only two discrete options possible. The reality is that consumptive

use exists on a continuum between fully consumptive and fully non-consumptive with the return flow representing where on the continuum a particular user lies. Since return flows are returned to the system and available to other downstream users, I think it is very important to include them in the analysis (even if a parameter representing return flow is set to zero for some Turkish irrigators). Many hydropower-irrigation systems in the western U.S. (such as the Colorado River system) rely heavily on return flows and they also play an important part of many water allocation and water rights schemes there and elsewhere.

2047/15 Shorten to "SDDP extends traditional discrete stochastic dynamic programming (SDP) to handle a larger state space."

2047/25-15 The terms r_t and i_t need to be explained. I understand from context r_t is release in time t, but this needs to be stated. I have no idea what i_t represents. Also, the specification of the connectivity matrix term C_R is inconsistent with the other terms in Equation 2 since the equation is general and does not refer to any particular junction or node. Also, f_t is defined as a function of s_t, q_t, and r_t in Equation 1, but as a function of s_t, r_t, and q_t in Equation 5. Shouldn't the ordering be the same?

2048/2 What is meant by the term "reservoirs of accumulated water"? More generally, I think this paragraph needs to better differentiate what is being modeling and what changes between Equations (1) – (6) and (7) – (15).

2048/11 $f^{\wedge i,d}$ is too easily confused with f_t. I suggest using a different letter to denote the former.

2048/Eq. 7 Are the annual net benefits over the irrigation season at each irrigation demand site strictly additive with respect to water applied each month of the irrigation season? I don't think so. Not irrigating (or irrigating below the plants' minimum survival requirement) in any one month would kill crops so that no benefit could be obtained regardless of how much water is applied in subsequent months. Further, stress irrigating in an early month could retard crop growth that may not be recoverable with additional irrigation in later months. This part of the formulation needs to be revisited.

2049/Eq. 9 i_t appears on the left side here but on the right side in the counterpart Eq. 2. Also, i_t still requires definition and explanation.

2050/Eq. 13 Why are limits on i_t applied in this model but not earlier in Equations (1) – (6)? Again, better differentiating the two models per the comment above would help greatly.

2050/13 & 19 Substitute "benefit" for "beneficiate".

2050/18 What is meant by the word "productivity"? Productivity of what? How to measure or quantify?

2051/11 Here, introduction of the term I_t is inconsistent and conflicts with the prior definition of I_t as spills in time period t provided on p. 2048. This inconsistency needs to be resolved as subsequent discussion of I_t is unclear.

2051/14 "Supplies" or rather "allocations"?

2051/Eq. 16 Is missing a negative sign or $[I_t - i_t]$ should be reversed to $[i_t - I_t]$ since α represents benefits and should be positive. Here, it appears (although it is not possible to say conclusively given the inconsistencies and missing explanations discussed above) that i_t is the water right and I_t is the actual allocation which should be less than the water right.

2053/20 "70s" should be expanded to "1970s".

2055/21 I don't follow how the written description corresponds to the equation. Should it rather be $s_t + q_t - e_t \geq i_t$?

2056/5-9 This explanation of i_t needs to go much, much earlier. And yet, I'm still confused. Isn't i_t the water right (static) allocation and I_t the dynamic allocation so that $I_t \leq i_t$ rather than the other way around? Or is it something else? This interpretation is also potentially confused because I_t was previously defined as spills.

2057/7-8 Results including averages are over what time period or length of time?

2057/Eq. 22 Simply repeats Equation 19. Is the second listing here necessary?

2062/Table 1 Third column heading should be "Rated Capacity" not "Capacity."

2064/Table 3 Table title is unclear. Additional benefits of what?

2067/Figure 2 Line connecting the second node to Irrigation – site j should have an arrow (similar to the other water flux lines, rather than a line with an arrow above it. An additional line should also be added to represent return flows. Also, I suggest using dashed lines to represent the financial transactions rather than the line with a different arrow head. This demarcation will more clearly differentiate the two types of flows.

2069/Figure 4 Y-axis of this figure and subsequent Figures 6-8 need to be better labeled. F in the paper denotes the benefit-to-go-function, but here it seems to indicate something else, such as a cumulative distribution. Also, the text above the figure ("Empirical CDF") here and in subsequent Figures 6-8 needs to be removed and incorporated directly into the Figure caption. Also the figure caption is unclear. Difference between what? What does the difference show?