Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2019-274-AC2, 2020

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Spatially variable hydrologic impact and biomass production tradeoffs associated with Eucalyptus cultivation for biofuel production in Entre Rios, Argentina" *by* Azad Heidari et al.

Azad Heidari et al.

dwatkins@mtu.edu

Received and published: 10 January 2020

RC2: But, the application of Eucalyptus is a challenge in SWAT, as it might be the first implementation (as stated by the authors). SWAT usually struggles with tropical forests (as acknowledged in line 1 of page 10, SWAT simulates dormancy in forests), and would for that reason not be suitable for this study.

AC: We agree this was a challenging application of SWAT, but we attempted to make the improvements necessary to simulate the full life cycle of eucalyptus growth. For example, the dormancy was a very brief period (only two weeks), which was accounted for during the calibration and did not have a significant effect on the ET or biomass growth. We hope to make a contribution to the literature, as further attempts for coupling forest and hydrology models are required.

RC2: It is well written and a good description of the model application and evaluation is given.

AC: Thank you.

RC2: a) How are the seasonal dynamics simulated?

AC: Seasonal discharges (both surface flows and base flows) are represented fairly well by the model, as shown in Figure 3. Data for seasonal biomass growth was not available, but growth dynamics are simulated based on solar radiation, temperature and precipitation that change seasonally.

RC2: b) What is the influence of the simulation of dormancy on the results?

AC: Although there is a short dormancy period simulated (2 weeks), we made adjustments to make sure it did not significantly affect the results. This is briefly discussed on (P6, L2): "The biomass growth calibration accounted for losses during the dormancy period, and simulated biomass at the time of harvest matched reported biomass yield in the area (INTA, 2016)." The only potential impact of the dormancy could be the slight underestimation in ET in that period.

RC2: c) How is the interaction with the roots simulated? SWAT is typically not doing this, except if one would use REVAP parameter to mimic this process, but this is not linked to any vegetation/root parameter.

AC: REVAP controls a process in which water moves into the soil zone from a shallow aquifer in response to water deficiency. This process is significant in watersheds where the saturated zone is not very far below the surface or where deep-rooted plants are growing. In our case, soils are deep (resulting in a deep saturated zone) in the eastern parts of the watershed where eucalyptus is mostly growing. Also, relatively high average precipitation throughout the watershed prevents water deficiency. Thus, the impact of REVAP was not significant in this case study. Furthermore, changing this parameter would result in a change in ET and the overall water balance. Since the simulated ET was reasonable compared to literature values, we chose not to change REVAP from the default value in SWAT.

RC2: d) How are the trees reacting to drought?

AC: As shown in Figure S1, the trees are generally resilient to droughts that occur during this hydrologic record. We noticed some sensitivity to drought near the end of the rotation, when LAI is near a maximum (e.g., 2006), resulting in a slightly lower yield for that rotation. We can discuss this further in the revised manuscript.

RC2: 2. Are the simulation results on yields realistic (cfr line 12 of page 8)? Are the relationships with soil depth and precipitation confirmed with observations?

AC: Yes, the simulated yields are realistic, and they were calibrated based on reported values in the region. This is explained in (P7, L2). The average simulated biomass yield was 75 tons/ha/rotation, matching the average reported values for the region (INTA, 2016). The range of 70-80 tons/ha/rotation is also reasonable, and consistent with the eastern part of the watershed having more plantations, where soils are deeper and rainfall is higher.

RC2: 3. Line 17 says "The parameters controlling LAI were adjusted during the hydrologic calibration to optimize ET simulation" but I don't find any comparison or evaluation for the ET simulations. My suggestion is to provide the Hydrological Mass Balance as a check, ideally also ET is evaluated for Eucalyptus.

AC: We mention on (P7, L13): "The eucalyptus plantations had the highest annual average ET rate (842 mm/year). This eucalyptus ET rate is similar to what Stape et al. (2004b) reported for high-class productivity eucalyptus in Brazil." The value reported by

Stape et al. was 880 mm/yr, which is about a 5% difference. Note that LAI parameters were also adjusted to represent the biomass production.

RC2: 4. The CN values became very low, and the recharge_DP parameter is very high, and might lead to unrealistic results in the hydrological mass balances with too high deep losses (which are not going to the outlet).

AC: We considered these parameter values carefully in ensuring that the water balance was reasonable. As mentioned, we performed a baseflow separation and required the simulated ratio of baseflow to total flow to be within the historical range. The overall water balance of the watershed is: P = $\sim$1220 mm/year ET = $\sim$812 mm/year Streamflow = $\sim$300 mm/year The Deep Recharge parameter seems high, but simulated deep recharge is around 100 mm, which is less than 9% of the precipitation. Physical justification is that the eastern portion of the watershed has deep soils and drains into the Uruguay River.

RC2: 5. Some details are missing. Which evapotranspiration method was used? Which routing method was used?

AC: The ET method is Penman-Monteith (P5, L1). Penman-Monteith was selected as it is a standard method recommended by FAO for ET calculations. The routing method is the Variable Storage Routing Method, the default routing method in SWAT. We will add a sentence identifying this routing method.

RC2: In summary, the model needs a better check, both in the calibration of the hydrology as on the implementation of Eucalyptus in SWAT. In my opinion, SWAT in general, and the model application for this case study, is not ready to be used for scenarios on Eucalyptus plantations and this might lead to wrong conclusions.

AC: We agree that one would need to be extremely cautious in applying model results to make decisions. This is one reason for including a section on study limitations, which will be expanded to accommodate insights from reviewers. We hope that we can convince the reviewer that the model is adequately calibrated and validated for both hydrology and plant growth simulations. To summarize the checks that were done: 1)The hydrological model passes standard evaluation tests, including: a) Pbias of less than 10% shows the very good performance of the model on the overall water balance; b) NSE of 0.6 shows better than satisfactory (>0.5) and close to very good (>0.65) performance of the model on monthly flow (Moriasi et al., 2007). 2) ET values match reported data in the literature. 3) The ratio of baseflow to total flow (annually) is maintained within the historical range, based on a baseflow separation. 4) LAI values match the regional measured values and values reported in the literature. 5) Biomass production values match the reported values for the region (Figure S1). 6) N uptake of the trees is in the range reported in the literature. (P7, L3)

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2019-274, 2019.