Review of Management Scenarios for the Chesapeake Bay Program's Phase 6 Watershed Model

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December 17, 2016

Resources Used

- Resources provided consisted of a limited RUSLE2 exported database containing only the management and profile files and their dependent components selected or developed for this study.
- I utilized the latest RUSLE2 version 2.6.2.1 June 1, 2016 for this review.
- The main focus of my review was the contents of the management files, what system they represented, whether they contained errors, and how they could be improved.
- I drew heavily on my previous 18 years of experience in building and managing the NRCS RUSLE2 database and training hundreds of RUSLE2 users in the proper construction of management files.

Alfalfa

- The range of values is quite wide ranging from 0.01 to 0.17.
- Files did not consistently contain proper yield entries for the different harvest cuts as the season progressed and used incorrect regrowth files following each cut.
- Files did not contain consistent species or mixtures.
- Files did not contain consistent length of period being modeled.
- For consistency, the description of what is being modeled should be more specific and specify the length of time this perennial is to be modeled. Avoid comparing straight alfalfa to alfalfa grass mixes since canopy and ground cover are different.
- The number of years that alfalfa is grown before being re-established and the planting season (spring vs. late summer) should be consistent across the states and CMZ's for this study if consistency is expected.

Pastures

- The pasture files are a mixture of different species and grazing systems ranging from hay species with harvest cuts instead of grazing operations, to rotational grazing of nurse crops in the first year only all the way to short duration high intensity grazing systems.
- The file with the high net C factor is a hay file and contains no grazing operations and no pasture species in it.
- Another file represents planting and harvest of a small grain nurse crop and is set to repeat the tillage, planting and harvest every year.
- There are significant differences in the RUSLE2 Net C factors because apparently no consistent standard format, common species or defined grazing system was specified in the instructions.
- Just as you specified a specific crop and tillage system or other crop groups, I recommend specifying a species or forage mixture and grazing system common to the area and allow the variability of climate and production level account for the variability across the region.
- Utilize the new perennial vegetation science and grazing planner in RUSLE2 to revise these pasture files.

Corn and Wheat

- The wheat harvest dates are more indicative of winter cover crop termination or grazing or silage or haylage harvests. These files are not labeled as double cropped scenarios and no clear description of what this crop group was intended to be was spelled out anywhere in the materials I was provided for review.
- To further add to the confusion, there is a statement in Appendix D of the report on page 7 that leads me to believe that the Corn and Wheat scenarios are really intended to be a Winter Cover crop of wheat followed by corn. It reads: *"Finally, the start date of a **winter cover of wheat** (e.g., Corn & Wheat) is the essentially the same day of the summer cover crop harvest, and the winter cover's end date is the start date of the summer cover crop's date range."*
- *USDA Economic Research Service says: "Strictly defined, "double cropping" refers to the harvesting of two crops or commodities in a calendar year, ….. "Cover cropping" involves planting two crops but harvesting only one crop……. And "Integrated crop-livestock systems" involve harvesting one crop and then putting livestock to forage on either residue or a second crop".*
- These Corn –Wheat RUSLE2 files have one common issue in that they all are harvested wheat for grain on April 30 which is much too early for the wheat to be physically mature enough for grain harvest. That would be a more typical date for terminating a cover crop or grazing the wheat as forage.

Corn and Wheat continued

- The USDA National Agricultural Statistics Service report of Usual Planting and Harvest Dates support late June to Mid July wheat harvest dates rather than the April 30th date contained in the Corn-Wheat and Soybean-Wheat files.
- These Corn and Wheat management files are inconsistent in what they represent.
- Some contain operations not compatible with the crop harvested.
- Some files remove the grain and most of the cornstalks while others somehow harvest corn leaving most of the corn stalks still standing.
- Some contain planting operations not compatible with the tillage system intended and not compatible with the residue conditions being planted into.
- Some files baled and removed wheat straw while others did not thus significantly affecting residue amounts left and the net C factors.

Soybeans and Wheat double cropped management scenarios

- There are similar problems with the Soybean and Wheat double cropped management scenarios in this crop grouping having wrong planting and harvest operations, and missing tillage operations if they are to represent plowed systems. The harvest date for wheat is universally too early as described under the Corn Wheat discussion above.
- I recommend that all Soybean Wheat management files be corrected as illustrated in my report and that all the runs be re done in this crop category. Wheat stubble harvest is optional but should be assumed or not assumed in all double cropped scenarios to reduce variability when comparing outputs across states and CMZ's.

Wheat for grain

- These files appear to be in pretty good shape except the DE wheat file is not for a plow based tillage system and did not bale and harvest the straw therefore a significantly lower net C factor of 0.08 resulted.
- Several of the other wheat grain files I checked include a plow and disk and baled the straw after grain harvest but some omitted the straw baling. This inconsistency in the amount of crop residue being left after grain harvest affects the Net C factor.
- I recommend a common scenario be defined as to tillage system and whether the straw is baled and removed or not removed and depending on the decision, the Wheat grain management files be revised accordingly to represent the same system throughout the watershed and re run.

Corn for grain

- I found some errors and inconsistencies in these corn grain management scenarios.
- Some files included a stalk shredder after harvest that would increase the percent residue cover over winter and early spring prior to plowing when compared to systems lacking this operation.
- Corn grain files in MD, NY and PA are very similar and correctly built. Yields are similar but compared to the DE and VA corn grain files a more aggressive harvest operation leaving only 30% standing stubble and an additional stalk shredder operation are included that flattens the corn residue thus lowering the C factor and increasing the residue cover.

Corn for grain continued

- The yields are fairly consistent but there are some errors in the no plow managements such as incorrect planters and row cultivations that would not be done in No-till systems and some post emerge sprayer operations two months too late in the growing season.
- I recommend that the corn grain Not plowed system to be modeled and compared across the region, be more consistent as to whether stalk shredding be done or not and that when Not plowed is modeled that the correct operations be included for a No-till system.

Corn silage

- This group appears to be fairly consistent. Corn Silage yields are consistent. The plowed scenarios appear to be built fairly well except for incorrect planter operations in a few cases.
- However, there are inconsistent operations in the not plowed scenarios including conventional planters and row cultivations that would not be correct for No-tilled conditions. This additional tillage buries residue and increases Net C factors over what they would be if built correctly for no-till.

Cucumber

- I compared the low value file to one of the higher files. These are two different systems. The DE file is flat planted and uses mechanical weed control vs. the PA 4.1 file which is bedded uses plastic mulch. I recommend that one common system be described and the files revised to allow the same system to be compared.

Other managed hay

- There is a large variability in the Net C factors in this Other Managed Hay crop group because the managements do not describe similar systems. Additionally the files representing Net C factors that were assumed to be correct, are in fact, incorrectly built.
- I recommend that decisions be made to revise all the Other managed Hay scenarios using a species common to all areas such as Tall fescue and use proper vegetation files in the correct order and modeled for at least a two year fully established period.

Potato

- There is high variability in this crop group even within the same CMZ. Although the yields are the same, the systems are significantly different with the VA 66 potato scenario planted on raised beds with extra tillage and harvested with **residues left** on the surface while the MD 66 Potato scenario was flat planted and harvested with **residues buried**.
- I recommend a common planting and harvesting system be decided upon and all the potato files revised accordingly and re run.

Soybeans

- While the comparison table shows some moderate difference across the group I found the soybean file representing the highest Net C factor and the file representing the lowest Net C factor to both be reasonable but differ in the harvest operations and thus differ in the amount of flat residue at harvest.
- Normal differences in Net C factors across the region are caused by differences in planting dates, differences in varieties, row spacing and in yields.
- If any revisions are made, further defining a common harvest stubble height to be modeled across the region is recommended. The no plow scenarios should use correct planting operations for no-tilled soybeans

Tomato

- These were confined to VA CMZs and the management files appear to be well constructed although the “plowed” system utilized several tandem disk operations and are on raised beds with plastic mulch instead of low cover conditions such as a plow tillage scenario.

Watermelon

- This is a fairly tight comparison. The files represent a similar tillage system but there are differences in planting dates across the region as expected.
- However the MD 4.1 Watermelon file is built for **pumpkins.** This is a different crop with different harvest date than watermelon. Corresponding yields are different therefore residue amounts are different.
- I recommend this file be corrected to bring the lower Net C factor more in line with the others.

Minor crops

- I did not review these minor crops since they contained only single examples with no other choice to compare.

Conclusions and Comments

- There are numerous inconsistencies in the management files for most crop types because they have errors in them and often don't represent the same general system within the crop group when compared across state and CMZ boundaries.
- In some cases such as with the Corn and Wheat and with the Soybeans and Wheat double crop files they are generally all built incorrectly because the harvest date for wheat is too early for grain harvest.

Conclusions and recommendations

- I recommend developing more specific descriptions of the crop group covering what species is harvested as is in the case of pastures and other hay crop groups. The descriptions for all the grain crops should specify whether crop residues are also harvested or not.
- I recommend that revisions be done by a well trained RUSLE2 user with experience in building RUSLE2 managements and a thorough knowledge of cropping systems, tillage systems, crops and field operations and the databases and how the internal operations processes and vegetations growth curves work in RUSLE2.

Cover crop effects are an integral part of the cropping system yet not modeled as such in this study

- Correspondence from Olivia Devereux in which she stated that "*No cover crops are modeled. Cover crops are a BMP and we need data for a no-BMP system. The cover crop BMP is accounted for outside of these RUSLE-generated data.*"
- I am concerned that, in the study, by modeling cover crop effects separately outside the cropping system and separate from the Net C factor, this approach may not capture the daily changes in roughness, cover and canopy interrelationships that cover crops have with other crops being grown in the cropping system and tillage system.
- The cover crop benefit to erosion and sediment deposition depends heavily on when the cover crop cover occupies part of the crop interval in relation to the distribution of erosive rains and whether the cover crop residue is killed and left on the surface, plowed under or grazed or removed as forage and how the kind, amount and composition of that plant material affects the erosion processes in the grain crop that follows it.
- There is no accurate "one size fits all" coefficient to represent a cover crop, since the benefit depends on the specific situation and whether it is correctly modeled on a daily basis as part of the crop management file that results in the Net C factor