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Hydrology and Earth System Sciences Discussions



# *Interactive comment on* "Future directions for hydropedology: quantifying impacts of global change on land use" *by* M. J. Vepraskas et al.

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The authors want to thank Drs. Bouma and West for their kind, and thought-provoking reviews of our work. We agree with most of their comments and will make appropriate revisions. The following provides our responses to their comments.

Repsonses to J. Bouma

1. We discussed alternative septic systems in very general terms because there are a variety of systems available, and different kinds are preferred in various parts of the U.S. Dr. Bouma is certainly correct that mound systems, which utilize a raised bed for the application of waste water, can be used effectively. We did not explicitly mention mound systems because to our knowledge they are not used extensively in

the southeastern U.S. Part of the reason for this is simply that when mounds were first installed, for example, in North Carolina in the 1970's they were installed improperly and failed. After hearing of reports of failures, homeowners became leery of using mound systems. The concept of the mound system is sound, especially the idea of pumping or dosing the waste water periodically into a network of pipes that are elevated above the soil by placing them in a bed of sand.

The type of alternative system we referred to is the "low-pressure pipe distribution system". This is a system of pipes that are buried within 30 cm of the soil surface. Waste water is pumped into the pipes periodically under pressures that allow for even distribution throughout the pipe network. In essence, this distribution system uses the same concept as developed for mound systems. The major difference is that the pipes are placed near the surface of the soil rather than in a bed of sand as used for the mound. We will try and make these points clearer in the revision.

2. Separation distances of 60 cm, that is the distance between the seasonal high water table and bottom of the septic drainline or trench, were shown to be most effective to attenuate microorganisms in unsaturated soil. However, in the Coastal Plain region of the Southern U.S. it was found that too little land actually met these requirements. Land developers wanted to place septic systems in soils with higher water tables. In some cases when state laws prevented them from doing so, they sued the state and judges decided that a 30 cm separation distance was adequate. Subsequent research was then done to determine proper application rates to attenuate microorganisms. We have focused on separation distance, rather than application rate, largely for convenience.

Responses to L. West

We appreciate Dr. West's general comments that are in support of our methods. He has raised excellent points that we will attempt to address.

p. 1743, l. 5: Separation distances from trench bottom to the water table do vary somewhat by states and not all states in the U.S. use the same methods for determining them. Separation distances in NC do vary by texture, and we believe the same is true for a number of other states, but we do not have any information on numbers.

p. 1744, l. 5-8: It is correct that we are referring to wetland hydrology parameters that are used to protect what are called “jurisdictional wetlands in the U.S. These are the wetlands protected by federal and state laws. We selected these hydrology parameters because they are well defined, and require that these wetlands be protected. Should an upland area become a jurisdictional wetland as a result of climate change, land owners could be required to stop any further development in that area. However, similar methodology could be applied using different criteria for wetlands as appropriate to the situation.

p. 1745, l. 25-28: The suggestion that we better define map units, and recognize that they contain components with differing drainage classes is a good point. Our initial intention was to use the dominant soil or drainage class for a given map unit. That would seem to be most appropriate for identifying the areas that could be impacted by climate change. More detailed work can be done for sensitive areas later, possibly areas in high population growth. Such additional work could include looking at the different components of the map unit and assessing these individually. If the areas of the map unit components are known, then probability values might even be considered that reflect the chance that a given map unit will have a soil area affected by the climate change. This is an area that we recognize more work is needed, and appreciate the suggestions of Dr. West.

p. 1746, l.10: The reference for the Soil Survey Manual will be included in the final version.

p. 1747, l. 6-8, and 11-16: We have come to realize that these sections have created more confusion in readers and reviewers than we expected. Their concern is that we are separating soils on the basis of drainage class and subsoil texture. That is correct in part, however, it must be realized that our first step was to select “toposequences” of soils for study in a restricted geological province. These toposequences will consist of soils along hillslopes that formed in similar parent materials and differ primarily in drainage class in the Coastal Plain region. We expect that drainage classes will vary due to differences in elevation. Accordingly, when a toposequence is studied many other soil properties (mineralogy, surface texture, subsoil structure, organic C levels, horizon types and thicknesses, etc.) should vary within a restricted range along the catena. Each soil we evaluate in a toposequence will be found in a specific soil series that has been used to define a soil mapping unit. When we calibrate our models for a poorly drained soil in one toposequence, say for example a Rains loamy sand, that soil will have a set of properties (textures, mineralogy, structure, etc.) that will be reflected in the calibrated model.

We propose to extrapolate the modeling results to other Rains soils in the Coastal Plain. To extend the extrapolation even further, we propose to also apply the Rains models to other poorly drained soils that have the same family particle size class. What we did not mention, and should have, that these other soils will also need to have a similar mineralogy as found in the Rains. This is because when mineralogy changes the saturated hydraulic conductivity may also change.

In the Coastal Plain region of North Carolina, and other states in the southeastern U.S., toposequences have been defined that differ largely on the basis of subsoil texture, or more accurately, family particle size class. We assume that for these toposequences the soil mineralogy will also change with particle size classâĂŤfor the Coastal Plain region. For the reasons Dr. West mentions, model extrapolation cannot be done carelessly to any soil in the world that happens to have the same family particle size class as the Rains. That is not our intent here nor have we endorsed that approach.

We recognize that model extrapolation remains one research problem that needs much more work. However, the purpose of the method proposed is to identify areas most prone to climate change impacts over large regions. Once such sensitive areas are identified, then more specific studies can be done to “fine tune” the results. As in the discussion above, we will replace the term “textural class family” with “family particle size class”, which is as Dr. West states is the more correct terminology.

p. 1747m l. 24: Dr. West is correct that the particle size classes used in Table 2 are the ones common to the Coastal Plain region in North Carolina.

p. 1748, l. 13-14: Our intention is to first assign a drainage class for the individual soils of a toposequence using soil colors as determined on-site. The results from this should match what would be found in the Soil Survey Database. We will then use modeling results that show average water table depths over the course of a year to define the water table signature that is expected for each drainage class. This is what is shown in Figure 3 where mean depths to water table levels are shown for each month for each of four drainage classes. We can develop similar data using a calibrated model and 40 years of daily rainfall and temperature data. We will begin by assigning a drainage class to each soil studied using a profile description that is completed on-site. Drainage classes in this Coastal Plain region are based largely on depth to low chroma color. We will then compute the mean monthly depth to water table over a 40 year period for each drainage class. The morphology will be used to assign the drainage classification to the modeling results for that soil.

p. 1750, l. 27- p. 1751, l. 1: The confusion regarding Table 4 stems from a misprint in the line for “Average depth of water table”. Values for “Current Conditions” (30 cm) and “Low CO2” (30 cm) need to be reversed. This will be corrected in the revised manuscript.

p. 1752, l. 7: The SSURGO database will be referenced as requested.

p. 1752, l. 9-13: A question was raised as to what properties need to be considered when extrapolating modeling results using soil survey data. Drainage class, landscape position, and factors affecting saturated hydraulic conductivity of major horizons (e.g. particle size distribution, mineralogy, structure, etc.) will be of major concern. We believe that these properties will affect the amounts of water a soil receives, and how



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fast it drains away. In addition, simulation results can only be extrapolated across regions having similar amounts of precipitation and temperature. This would be our plan at this point, however, we emphasize that more research will need to be done on this issue.

p. 1753, l. 19-20: As discussed earlier, at this time there remains some uncertainty about the best way to handle inclusions in mapping units. More research on this issue is needed. For now, we propose to use the dominant component of a map unit for characterizing the entire map unit.

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