

Title: "Runoff evolution according to land use change in a small Sahelian catchment"

Authors: Descroix et al.

Journal: Hydrology and Earth System Sciences

General Comments:

The study describes an assessment of the impact of land cover change in two small watersheds in the Sahel utilizing field observations and a simple lumped model. While the motivation and goals are to be commended, the study falls short in many respects. In a nutshell, the manuscript is both a poor observational study (due to missing details, descriptions, analysis and interpretation of field data) as well as a poor modeling study (due to missing details, analysis and overinterpretations of a very simple model). In addition, the manuscript is poorly constructed, described and discussed. It should be rejected. Below I provide some specific and technical comments that may help the authors in a significant (if not total) reconstruction of their work. The manuscript needs a lot more work than just those that I have highlighted below. One idea is to simply focus on the observations and analyze these in more detail for their intrinsic value. The modeling part will probably not be publishable in any form. I wish I could be more positive, but this manuscript is simply not very good.

Specific Comments:

Page 1570.

Line 7. Please indicate how different or similar the two catchments are.

Line 9. Where and when did vegetation clearing occur?

Line 14-16. An explanation of the future work is inappropriate in an abstract.

Line 1-16. Please focus the abstract on the major quantitative conclusions.

Line 18. References are needed for the changing land use in the Sahel. When was the natural vegetation altered?

Line 20-22. The description of the land use change and subsequent erosion are too vague. Be more specific to the sites or regions of interest.

Line 26. References to support this statement are needed.

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Line 4-8. These descriptions of hillslope crusting and downstream infiltration are very confusing to the reader. Please clarify and support with references.

Line 7. What are the physical mechanisms for increased transmission losses? Explain.

Line 9-21. Is this paragraph needed? The discussion of the two theories is tangential to this effort.

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Line 3. Please define millet biomass.

Page 1573

Line 4. A photograph of the study areas would really help the reader understand the site.

Line 12. How were the water level recorders installed? Are flumes or weirs utilized? More details on the measurement type and accuracy are warranted. What impact does the change in the water level recorder have on the comparison of the two periods?

Line 22. Where were the soil moisture sensors installed? At what depths? In which vegetation types? Which specific type of sensor? How were these installed and calibrated?

Page 1574

Line 1. Please show the soil moisture sensors and neutron probe access sites in the study area map. How were these sites selected?

Line 5. Where was the piezometer installed? How frequently were data collected?

Line 8. Please provide more details on the PIXY drone. Describe how the data were processed to generate contour lines and vegetation maps. Describe the resolution and accuracy. Was field validation performed?

Line 11. When were the images taken? If there is seasonality in the system, how was this accounted for in the two maps? Where the two aerial images taken in the same season?

Line 15. The model does not account for the 'main hydrological processes', it is a simple model with only runoff as a model predictand.

Line 17. Which variable in the model is soil moisture? Which variable in the model is the maximum runoff coefficient?

Page 1575

Line 1-24. The description of the statistical analysis is poorly constructed. What is the motivation for using this? Is it valid to carry out for a very small number of years? Why is it not carried out at the event scale?

Line 25. Prior to the results section, the authors should have discussed the instrumentation in more detail, the site characteristics and seasonality in more detail, and a few examples of the data sets collected (rainfall, soil moisture, piezometric levels, runoff).

Page 1576

Line 1. What are the crop rotations in the area and what is their timing relative to the natural vegetation seasonality. The differences seen could be due to images taken during different periods of the year, not necessarily decadal-scale changes.

Line 12. Please provide quantitative evidence that the sandy deposit increase in volume.

Line 14. How much confidence is there in the statement that fallow areas or sandy deposits did not exist in 1965?

Line 23. Are the differences significant in a statistical sense? The authors need to qualify their results of 'significance' with statistical evidence, here and throughout the manuscript. Some of the 'significant' changes appear to be rather small.

Line 26. The spread among the years within a period is about the same as the difference in the two periods. This lends does not lend support to the 'significance' of the change.

Page 1577

Line 1. How useful are the runoff analyses at annual scales? Should the authors consider seasonal or event scales to increase their sample sizes and improve the significance testing?

Line 8. The use of the term 'runoff coefficient' here is confusing with the prior analysis. This is in fact a regression coefficient, that is not precisely a runoff coefficient. Please clarify.

Line 13. This is the first mention of the rainy season. Thus, the system must be quite seasonal and the vegetation is likely to respond seasonally, giving more weight to the need for vegetation imagery in the same season.

Line 17. Is the decrease in the runoff duration from 28 to 18 hours possibly within the measurement error at the water level recorder? We don't know specifics of the two different measurement techniques or dataset to understand the significance of this change.

Line 21. How is the wetting front quantified? We have not been told how the soil moisture sensors were placed, so its difficult to understand the comparison made here.

Page 1578

Line 3. The species of trees had not been discussed previously (but should have been).

Line 12. It would be nice to see some of the data to be able to assess whether this statement is accurate.

Line 15. Given the simple empirical model, it is really not possible to say that it aims to 'improve modeling of rainfall-runoff relationships'.

Line 16-23. There is repetition here with the prior model description and the Appendix A.

Line 23. There is no Appendix B.

Line 26. The model is referred to as NAZASM in some occasions and as NAZAS in others, please use consistent terminology.

Line 27. Was the model calibrated manually? How? Which parameters are more important in this exercise? How are they kept with reasonable ranges?

Line 24. It appears that the history of the events does not matter, given the subsampling of the events. How is this possible if the antecedent rainfall is taken into account?

Page 1579

Line 3-4. That Hmax is related to the soil degradation is conjecture. There is no support for this.

Line 5-6. That Pmax is related to infiltration under gullies is also conjecture. Please support with evidence from the model and field data.

Line 7-13. Similar comments as above for Kmax and alpha. How is it possible to use an empirical regression model to obtain any insight about physical processes at the level of detail proposed here (for specific land use types and for specific creeks). This is inappropriate.

Page 1580

Line 1-5. What is the purpose of this statistical analysis? It appears to contradict the earlier statements that trends exist in the data and that these are due to land cover.

Line 1-5. Using these analyses for annual data is very limiting. Can you consider looking at event or seasonal scales where the sample size is much larger?

Line 8-9. This is a bit confusing. It appears that runoff is the same in the two period, but the volume divided by the duration varies. Is this not simply because the duration varied?

Line 12. The changes did not seem so large.

Line 14. How is it possible to use the reference from Casenave and Valentin (1989) to explain behavior that occurred later?

Line 16. Please link these two studies in separate regions to the findings here.

Page 1581.

Line 1-3. This explanation of the increasing area being responsible for the runoff coefficient greater than 100% is not well supported. Provide quantitative evidence for the reader to accept.

Line 4. The explanation now seems to have evolved away from land use change toward a variation in connectivity at a scale different from the land use change previously described. This is very confusing.

Line 22. The explanation of runoff losses to deeper gullies seems speculative. Can this be shown with the data?

Line 13-16. What is the relevance of the neutron probe results? Does it fit the overall theme of the study? Not clearly related.

Line 27. Did the great extension of gullies also happen at this study site?

Page 1582

Line 1-14. These references and cited values seem irrelevant for this study. If not, please link it better to the work here.

Line 18. Was a water table rise observed in this study?

Page 1583.

Line 3. Please show evidence for the effect of soil crusting in this study site.

Line 4. In a lumped model, parameters like Pmax are basin averaged, and thus their values cannot be attributed to particular locations such as gullies.

Page 1584

Line 5-7. Are these volumetric differences within the measurement error?

Line 8. Did the areas expand? Provide evidence.

Line 11. Is the shorter duration of the runoff possibly responsible for the higher transmission losses?

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Line 6. The square root should include dn as well.

Line 15. The variable K has not been defined.

Line 16. What is meant by 'By assimilating the soil to a reservoir'?

Line 23. Figure A1 is not referenced in the text.

Technical Corrections:

Page 1570

Line 21. Period after decreasing is needed.

Line 25. Most landforms are subject to erosion, thus 'erosion-caused landforms' is not an appropriate term.

Page 1571

Line 2. The term biological crust is more appropriate than algal crust.

Line 4. The verb 'constitute' is misused in this sentence, should be 'created'?

Page 1572

Line 16. Replace 'water cycle evolution' with 'evolution of hydrologic processes'

Page 1573

Line 17. Replace 'running event' with 'runoff event'

Line 21. Remove 'was'

Page 1581

Line 24. The use of the term 'creek' is probably not appropriate for systems that are dry 99% of the time. This occurs in other locations. A better term would be wash or ephemeral channel.

Page 1582

Line 1. Please modify 'talking about the fields and degraded areas'. Does not make sense.