Hydrology and Earth System Sciences Discussions

Interactive comment on "Rainfall threshold for hillslope outflow: an emergent property of flow pathway connectivity" *by* P. Lehmann et al.

Anonymous Referee #3

Received and published: 14 November 2006

Overview

I congratulate the authors on adapting a potentially very useful conceptualisation into hydrology. The paper makes good progress in addressing the research question (how to explain the threshold behaviour and the observed space-time patterns of water content). Their extensive use of measurement as motivation for applying this new technique is welcome. Their explicit treatment of the connectivity of adjacent soil elements is a nice step forward.

My main concern is that from their relatively successful model fitting exercise the authors infer that they have found the explanation for observed threshold responses. This

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conclusion seems premature, and I think it would be more accurate to say that this model structure (with some calibration) is able to explain the observations (rather than giving the impression that it provides the unique explanation).

Specific Comments (pagenumber: linenumber)

2924: 14-17 "variation in the relationship between rainstorm amount and subsurface flow is dominated by ..." "is dominated by" seems rather strong language, and is in essence a list of the parameters of their model. This is not the same as a list of real-world phenomena! The authors have shown that within their proposed model structure, these terms are significant. The authors did not introduce other plausible terms (slope angle, soil permeability) and show that they were NOT significant, which is what I consider necessary to claim a dominant effect. Perhaps the authors could reword to the effect that within their proposed model structure, the relationship can be explained.

2925: 11 "existence of a threshold appears to be a common property of hillslope drainage". A (leaky) bucket model of hillslope response that assumes a typical soil moisture deficit is capable of predicting a threshold response in rainfall-runoff. I think a discussion of the inadequacy of such models is needed. I would suggest that the real problem is not how to explain threshold response, but how to explain the observed combination of threshold response and space-time moisture patterns.

2926: 8 "We hypothesise that flow path connectivity is a first order control" I think more care is needed with the term first order control. Its meaning is highly context-sensitive, but the context is not made clear. What is first-order in one case is not in another. What are the other first order controls? Rainfall? Soil depth? Surface permeability? Vegetation? Is there anything that is not a first order control?

2929 - 2931 It is not clear to me that the graphs of P(p) and F(p) in Figure 3 really help the reader learn about the relevance of percolation theory for hillslope flow. Perhaps more work is needed to emphasise the physical significance of a percolation cluster, and of a site being "connected". 2938: 3 "to find an optimized model" What other

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combinations of parameter values would have given equally good simulations?

2942: 14-15 "As connectivity has been shown to be a first-order control triggering sub-surface flow, percolation theory is superior over conventional distributed hydrological model ..." I think this overstates the achievements of the paper. I was not convinced by the material in the paper that connectivity is a first order control (though I may well suspect it to be true, once "first order control" is defined). The paper shows some model simulations which are sensitive to a connectivity parameter, and which are able to simulate observed hydrological response. However, the connectivity parameter (co-ordination number) requires calibration and the connection to physical reality remain an open research question.

Minor comments (pagenumber: linenumber) 2924: 5: "we show that this nonlinear relationship arises" I would say "can arise"

2924: 23 "vadoze" vadose

2925: 3 "increase in flow with a slope less than 1.0". Some context is needed to explain the use of the word slope

2926: 26 "The water flows through soil sites with a water table" I'd suggest "flows laterally"

2926: 27 "soil close to the bedrock become" should be becomes

2926: 28 "only this free water can flow downwards" would downslope be mroe accurate than downwards?

2931: 22 "occupied and open with respect to water flow" What does it mean to be open to water flow?

2934: 6 "between -5 sigma (or 0) and 5 sigma" Do the authors mean "between mu-5 sigma (or 0) and mu + 5sigma" ?

2951: Figure 1. How were the links chosen which connect the nodes? There are many

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other ways of drawing lines between the measurement nodes.

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