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Hydrology and Earth System Sciences Discussions



# *Interactive comment on* "Geomorphology-based index for detecting minimal flood stages in arid alluvial streams" *by* E. Shamir et al.

**E. Shamir et al.**

eshamir@hrc-lab.org

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Geomorphology-Based Index for detecting minimal flood stages in arid alluvial streams – Authors response to reviewers comments

We thank Dr. Gerardo Benito and the anonymous reviewer for their constructive comments.

Comments from Gerardo Benito

Comment 1.- Regarding basin morphometry (point 1 from the mentioned three issues above). It seems obvious that the maximum flows or peaks generated by a catchments should be related by the catchment size, but in terms of low flows the range that one

should expect is more variable, since it may be generated by rainfall falling in one part of the catchment. I wonder if the relationships found by the authors were obtained by the bias in the selection of the water marks (e.g. all marks were produced by the same rainfall event during the previous rainfall season). I guess that higher water marks existed on the selected river reaches, but only the smallest ones were surveyed.

Authors Response : This comment articulates 2 valid concerns: a) It is argued that the basin drainage area as a descriptor for the low flow marks at the outlet's cross section might be questionable because many of the low-flow events are caused by localized rain that produce runoff from portion of the basin. However, the cross-section-wide characteristics and dimensions are closely associated with the effective discharge which, as presented in the Literature Review Section, in arid environment is assumed to have lower recurrence intervals and probably larger storms during which the entire drainage area produces runoff. Notice, that in this paper we analyze relatively small drainage areas which further corroborate the above statement. We added the following paragraph to Section 6, paragraph 8:

"Identifying the basin area as a regression predictor for the AFIG properties is an expected result. Although, many of the low flow events are caused by local rain-cells and during these events only a portion of the drainage area produces runoff, the channel cross sections in the basins outlet are tightly associated with the effective discharge. As discussed in Section 1.1, in arid climate the effective discharge is attributed to infrequent large events that likely to cover the entire basin's drainage area."

b) The reviewer notes that the surveyed low flow markers might have been created by a recent event that affected all the survey locations and therefore might have introduced a bias, which implies that the reported results are dependent on the timing of the survey. We believe this is a possibility for individual cases and we are aware of the bias and subjectivity of the selected markers. This is however an inherent feature in geomorphological surveys even for well-defined and well-studied indices such as those concerning channel bankfull. See for example, Williams (1978) which lists 11 methods



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for bankfull definition. We reworded the paragraph in Section 3, Paragraph 3 to better describe the various sources of uncertainties and highlight the consistency of the index geometry among various cross sections:

"The heights of the above low water marks above the channel bed were often slightly different in opposite banks probably due to local, sub-reach hydraulic conditions that are difficult to discern. In addition, they could have been formed by deeper local flows or by a relatively large and recent regional event (Graf 1988). Irrespective of the inherent sources of uncertainty it was reassuring to find that these marks were identified in 42 out of the 46 reaches surveyed and in most of these they were consistently situated at 15-46 cm above the thalweg."

2.- Regarding bankfull discharge. I agree that many authors have concluded that frequency of bankfull flow appear to be in the range between 1 to 2 years on the bases of annual maximum flood statistics (Wolman and Leopold, 1957; Dury, 1976; Harman et al., 1999; Navratil et al., 2006). However, the authors do not mention further studies carried out in semiarid catchments that demonstrated that recurrence associated to bankfull discharge in regions with flashy hydrology is higher than those with less variable flows (Williams, 1978, Havery, 1969; Pickup and Warner, 1976), and that the recurrence may range in those cases between 1 to 6 years (Leopold 1964; Gomez, 2006). This difference on recurrence intervals for Bankfull discharge in semiarid regions should be mentioned in the paper.

Authors Response : We added some of the suggested references to strengthen the argument for deviation from the conventional agreement of the recurrence interval for the bankfull flow. We found only few references that deal with bankfull flow's recurrence intervals in arid ephemeral streams. Most bankfull studies that included arid and semiarid ephemeral basins introduced in their final analysis a broad range of climatic regions. Therefore we believe that the statement of 1-6 year return period although appearing reasonable is yet not well supported by the literature. We reworded the second paragraph of the Literature Review Section to include specific finding in arid ephemeral



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streams.

“Using annual peak discharge series, Leopold et al., (1964) reported that the return period of bankfull flow is approximately 1 to 2 years. This return period was later confirmed as a reasonable a priori estimate although a wider range of estimates of return period have been reported (e.g. Harvey, 1969; Dury, 1973; Williams, 1978; Gomez et al., 2006; Schneider et al., 2011). Bankfull flow studies in arid and semiarid ephemeral streams reported various ranges of reoccurrence intervals: e.g., 1.1-1.8 years in Arizona and New Mexico (Moody et al., 2003); 4-10 years in New South Wales Australia (Pickup and Warner, 1976) ; 0.3-3.3 and 1.5-10.5 years in Southern California (Carpenter, 2011; Coleman et al., 2005, respectively). “

3.- It is true that bankfull discharge may be several times greater than that of effective discharge (Pickup and Warner, 1976). However, the overall channel geometry is likely determined by discharges at or near bankfull, because width is constrained by the stability and resistance of the bank material to erosion during high flows that also scour the bed (Gomes et al., 2006). I wonder if the minor low flows are only partially modifying the work carried out by large floods and that is modifying the statistical relationships found in the paper, namely with and water depth.

Authors Response : A better understanding of the channel geomorphologic work from low flow events in arid ephemeral stream is an interesting question and we believe that further research on this topic is warranted. It is however beyond the scope of this specific study.

COMMENTS FROM ANONYMOUS REVIEWER: Abstract: In the abstract, the geomorphic index is presented as a ‘lower threshold for minor floods’ which is associated to flash floods. Actually, there is not a ‘higher threshold’ presented in the work. I suggest to reword this sentence in order to avoid possible misunderstandings.

Authors Response : Thanks, the sentence in the abstract was reworded and clarified:



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“Identification of a geomorphic index to represent lower thresholds for minor flows in ephemeral, alluvial streams in arid environments is an essential step as a precursor for reliable flash flood hazard estimations and establishing flood warning systems.”

Introduction: please add a sentence illustrating how the new index can be coupled with a model for flash flood forecasting to issue a warning.

Authors Response : We added a paragraph to the introduction that describes the potential usage of the low flow index in flood warning system.

“This study is motivated by the need to identify field-based geomorphologic marks of low flows in ephemeral arid streams that can be indicative of minor flash floods in arid ephemeral streams. These geomorphologic marks can potentially be estimated for ungauged and un-surveyed basins as low-flow indicators. In conjunction with hydrologic model these marks provide a continuous and dynamic risk assessment that identifies the short term hydrologic conditions that can lead to these flows given continuously changing antecedent conditions. Such a modeling framework provides a tool for forecasters to assess short term forecasts and issue flash flood watches and warnings for specific locations (e.g., Georgakakos 1987; Reed et al., 2002; Shamir et al., 2013).”

Introduction: The text states that there is an association between bankfull flow, the corresponding 1-1.5 yr return period, and the effective discharge. Actually, I would invite the authors to nuance the statements. Phillips (2002), for instance, reports that ‘Bankfull flow may well have a recurrence interval of 2 years or so - there is not enough evidence to judge - but bankfull discharge does not appear to have any special significance with respect to maintaining or modifying the channel. This suggests that channel dimensions and sediments in coarse-bed mountain streams are likely to reflect relatively rare, large floods rather than more common flows with recurrence intervals of 2 years or so.’

Authors Response : The sentence was edited to emphasize the nuance indicated by the reviewer:



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"A significant body of research has followed that verifies and in some cases contests the assertion made by Wolman and Miller (1960) (e.g., Leopold et al., 1964; Kochel, 1988; Emmett and Wolman 2001; Phillips 2002)."

Concluding remarks. This section states that "In arid environments there are many cases when even the largest flows do not overflow the channel's sometimes undefined banks. Furthermore, planners in arid environments indicate that even the occurrence of low flow in the channel might already be considered as requiring warning." The authors should report, both here and in the introduction, why there is such a difference between temperate humid and arid environments and which are the implications (i.e., they could develop on the observation that in arid environment, where ephemeral rivers are the rule rather than the exception, vulnerable properties, assets and activities are often located within the rivers, hence a different concept that bankfull flow is required to issue a warming).

Authors Response : This is a very interesting topic that basically sums up to the fact that floods and the risk of floods are different and perceived differently in arid versus temperate regions. In the Literature Review Section we tried to articulate these differences and touched on geomorphological differences. We also discuss the hydrological processes perspective of ephemeral streams in Section 2. We do think, however, that the issue of differences in floods between arid and temperate regions deserves special attention and should not be combined as one topic. Beyond the natural science perspectives of flash floods (i.e., geomorphologic-hydrologic-meteorological processes) there are probably other differences that involve societal, economic and cultural aspects such as that relate to perception of extreme flood events and planning and regulation requirements. All should probably be the focus of another study that requires additional investigation. We agree with the reviewer's statement that in many ephemeral streams assets and activities are often located within the channels. We added the following statement in the introduction Section paragraph 2:

"In addition, in regions where ephemeral streams are predominant, vulnerable proper-



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ties assets, and activities are often located within the channel of the rivers."

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