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Hydrology and Earth System Sciences
Discussions

Interactive comment on "How to determine the effective discharge and its return period in a semi-arid basin? The case of the Wadi Sebdou, Algeria (1973–2004)" *by* Abdesselam Megnounif and Sylvain Ouillon

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Anonymous Referee #1 Received and published: 4 June 2018

Replies by the authors

R1: The paper is interesting and well within the scope of the journal, nevertheless it needs to be reinforced with reference to several points, mainly regarding paper clarity and organization.

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Reply: Thanks for the general comment and all your suggestions to makes the paper better organized and clearer.

R1: The title should more informative and let the reader know that it deals with sediment transport and hydrological implications.

Reply: We propose a new title: “Mean and analytical methods to characterize the efficiency of floods to move sediments in a small semi-arid basin”. The mean method refers to the use of histograms where each class of discharge is represented by its mean value, and the analytical method in which the dominant discharge is defined as the solution of h’(Q)=0 where h(Q)= f(Q).g(Q), f(Q) being a probability function of the flow frequency and g(Q) a sediment rating curve. These names are used in the literature, see for example Crowder and Knapp (2005) and Lenzi et al. (2006) for the mean approach, and Nash et al. (2005), Goodwin (2004), Quader et al. (2008) and Bunte et al. (2014) for the analytical approach.

R1: The introduction should be clearer with respect to the paper’s objectives and novelty. While it is clearly stated that three methods for individuation of discharge classes are compared, it is not evident how many and which methods are compared with reference to the evaluation of effective discharge, and other related methods including evaluation of return times.

Reply: We thoroughly revised the presentation of the paper’s objectives in the following way (new summary):

Over a long multi-year period, flood events can be classified according to their effectiveness in moving sediments. Efficiency depends both on the magnitude and frequency with which events occur. The effective (or dominant) discharge is the water discharge which corresponds to the maximum sediment supply. If its calculation is well documented in temperate or humid climate and large basins, it is much more difficult in small and semi-arid basins which encompass short floods with high sediment supplies. On the example of 31-years of measurements in the Wadi Sebdou (North-West

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Algeria), this paper compares the two main approaches to calculate the effective discharge (the mean approach based on histograms of sediment supply by discharge classes and an analytical calculation based on a hydrological probability distribution and on a sediment rating curve) to a very simple proxy: the half-load discharge, i.e. the flow rate corresponding to 50% of the cumulative sediment yield. Three types of discharge subdivisions were tested. In the mean approach, two subdivisions provided effective discharges close to the half-load discharge. Analytical solutions based on Log-normal and Log-Gumbel probability distributions were assessed but they highly underestimated the effective discharge, whatever the subdivision used to adjust the flow frequency distribution. Furthermore, annual series of maximum discharge and half-load discharge enabled to infer the return period of hydrological years with discharges higher than the effective discharge (around 2 years) and to show that more than half of the yearly sediment supply is carried by flows higher than the effective discharge only every 7 hydrological years. This study was the first to adapt the statistical approach in a semi-arid basin and to show the potentiality and limits of each method in a such climate.

The revised introduction has been rewritten accordingly, and the structure of the revised paper as well.

R1: While the paper is strongly focused on issue related to the representativeness of available measures (discharge and concentrations), only few explanations are provided about physical processes related to sediment transport. The eventual presence of hysteresis which is at the core of many works on the topic is here barely mentioned.

Reply: This paper focuses on statistical analysis of sediment discharge. We tried to state it more clearly in the revised title. Physical processes are included through their "signatures" in the data collected all along the 31-year period of measurements but this paper does not study the time variations of parameters at short term. Only histograms, statistics and yearly values are considered. A specific study of hysteresis during floods (so at short term) was already published on the same basin (see our paper: Megnounif

et al., 2013, Journal of Hydrology). A sentence was added in the site description accordingly: “Previous studies on sediment dynamics in this basin proposed syntheses on the main parameters, or on sediment processes at the origin of hysteresis phenomena during floods, based on the detailed analysis of short-term time variations of water and sediment discharges (Megnounif et al., 2013).”

R1: A figure representing the basin and its position is missing and basin description is almost entirely addressed to other papers referenced.

Reply: The section title ’study area’ was changed to ’study area and data collection’. Its text was rewritten from former sections 2 and 3.3 (in reply to your next suggestion). A figure representing the watershed position was inserted.

R1: Also, the organization of section 3 Methodology, does not help the reader in understanding what the authors are mainly presenting and comparing. Making an exception for subsections 3.2 about class intervals, all other parameters are presented without any specif ic order of hierarchy. Subsection 3.3 about hydrometric measurements and pre-processing could be probably moved in section 2.

Reply: Section 3 was revised according to the new thread. Subsection 3.3 was separated into three subparts, two of which moved to the introduction and to the revised section 2. Other subsections of section 3 are now based on the mean approach, the analytical approach, the half-load discharge and the return periods.

R1: The evaluation of the Half-load discharge does not actually add any knowledge insight apart for a weak literature comparison.

Reply: As we show, the half-load discharge (29.8 m3 s-1) is a very good approximation of the effective discharge (either 29.5 or 29.01, depending on the discharge subdivision). Furthermore, it can be estimated very quickly from the dataset since it is directly readable from the cumulative sediment curve (Fig. 3), without any calculation. We thus propose to keep this indicator, which can be easily accessed for practical applications

by technical services or managers. The following sentence was added: “Its very quick and easy determination from the cumulative sediment yield curve makes it a suitable indicator for practical applications by technical staff or managers.”

Furthermore, in the Wadi Sebdou, the half-load discharge in 1973-1988, QY50 (7.68 m3 s-1), was close to the dominant discharge QD (6.7 m3 s-1) and not far from the modal class [6.1; 7.4 m3 s-1[; in 1988-2003, QY50 (31.80 m3 s-1) was very close to the modal class [26.4; 31.7 m3 s-1[whose center was defined as the effective discharge (QD = 29.0 m3 s-1). Thus, in the Sebdou Basin, the half-load discharge can be seen as a robust proxy for the effective discharge. This result fosters further warrants in future studies and in other basins. This was emphasized in the last paragraph of the discussion.

R1: The same applies to the subsection 3.7 Recurrence interval which is a mere evaluation of a certain discharge compared to the distribution of maximum and mean discharge.

Reply: The recurrence interval of a certain discharge like the effective discharge is traditionally calculated in hydrology. However, this return period is only based on hydrologic distributions (as you explain, from the distributions of mean and maximum discharge). We propose in this paper something more original, calculating a recurrence interval of the effective discharge compared to the distribution of annual half-load discharge, which was obtained from both water and sediment data time series, and investigate its additional information. The text was clarified accordingly.

R1: Figure 3, upper portion, should be placed in a different scale, data are almost invisible.

Reply: Thank you for the suggestion. We changed the upper portion in semi-log scale, so that data become more visible.

R1: Last sentence of page 17 is not clear, should be rephrased.

Reply: A subsection was entirely devoted to the return periods calculations. The last sentences of this subsection (4.2) were rephrased to: “The difference of nearly five years between these two estimates is attributed to their different meanings. While one indicates that the effective discharge is observed at least once in a hydrological year roughly every two years at the gauging station, the other shows that half of the yearly sediment supply is carried by flows higher than the effective discharge only every 7 hydrological years.”

Just above, another sentence was modified to clarify this topic.

R1: The striking difference between analytical and statistical approaches is simply distressing and does not find a satisfactory justification.

Reply: The comparison of the two calculations makes it possible to add information on the limits of the analytical method (based on a probability density function for the flow frequency). It did not provide good results in semi-arid environments because the sediment rating curve introduces errors (designed as ‘of the first type’ in the paper) and because pronounced asymmetric probability distributions failed to reproduce good frequencies of high discharge (errors ‘of second type’). Consequently, this comparison shows that the mean method by decomposition of histogram classes is the most suitable in a semi-arid environment. This had never been tested in the literature. It’s an original result. This was emphasized in subsection 5.4.

R1: Figure 9c and 9d, are hard to understand. Maybe that placing indications of number (1) to (6) on the time series (i.e. in figures 9a and 9b) may help.

Reply: Figure 9 and the former subsection 4.3 on the characterization of flows and associated sediment loads were deleted, to strengthen the paper on its main purpose and its originality.

R1: The discussion section is quite long and not always add useful information. Some parts could be shortened and moved to other subsections, for the sake of paper struc-

ture and readability. Other parts may be even canceled like lines 1-6 at page 25 or lines 1-10 page 26 or the entire 5.5 subsection.

Reply: The discussion was revised and shortened. In particular, the former entire subsections 5.3 (former lines 1-10 page 26) and 5.5 were removed, as you requested. Globally, the paper was reduced by ∼10% (around 9700 words against 10700 in the previous version).

Please also note the supplement to this comment:
https://www.hydrol-earth-syst-sci-discuss.net/hess-2018-189/hess-2018-189-AC1-supplement.pdf

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