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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

Abdesselam Megnounif and Sylvain Ouillon

sylvain.ouillon@ird.fr

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Anonymous Referee #2 Received and published: 26 July 2018

Replies by the authors

R2: I think this is an interesting manuscript potentially reporting on an interesting data set and a thorough analysis. However, in my opinion the authors fail to make a convincing case for while this paper is a significant and original contribution to the scientific literature.

Printer-friendly version

Discussion paper

Reply: Thank you for your general appreciation and your detailed comments and suggestions to improve the paper. In particular, the revised version underlines the originality of our work.

R2: The introduction is mostly a methodological introduction. There is some text in section 3.3 which does try to describe the scientific context of this particular study which could perhaps be used as a starting point for a more focused introduction, reviewing the literature and identifying knowledge gaps.

Reply: Thank you. We thoroughly revised the thread 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 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. In particular, the revised introduction now reviews the literature, identifies knowledge gaps and states more clearly the novelty of this paper. A part of the former section 3.3 was moved to the introduction, while some methodological information moved from the former introduction to the section 3 (such as the upper page 3 of the former version).

The title of the paper was also revised, as suggested by the referee #1, according to: “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 is such that the dominant discharge is 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.

R2: Also, the manuscript is quite long as there is a lot of fundamental methodology included. I think it would be more readable if the focus was more on the original aspects of the analysis with less reference to standard methods used.

Reply: The revised version was focused on original aspects of the analysis and some former paragraphs or sections (like the former sections 4.3, 5.3 and 5.5) were removed.

R2: The conclusion is very long. I would suggest a more concise set of conclusions would help to communicate the potential importance of the paper to readers.

Reply: The conclusion was shortened and focused on original aspects of this work. Globally, the paper was reduced by $\sim$10% (around 9700 words against 10700 in the previous version).

R2: In summary: this is potentially an interesting paper, but there is much that can be done in order to improve the quality of the presentation.

Other comments Section 3: Discharge is Q, concentration is C, and the product of the two is Qs. I find that notation a little confusing. Especially as a few lines down sediment load is denoted ΔY.

Reply: We used the traditional and most common annotation for Q (discharge) and the sediment flow. While subscript S stands for "sediment" discharge in Qs (weight or volume of transported sediment per unit of time), Y stands for sediment yield (in weight or volume of transported sediments), and QYα stands for a water discharge (and not a sediment discharge) corresponding to a cumulative sediment yield of α %. We used different names (and the most standard ones) for parameters of different units so as to avoid any confusion. However, you rightly pointed to a bad wording in the former subsection 3.1 when we referred to "inputs of sediment load" rather than elementary sediment yield, and "sediment yield Qs" instead of "sediment discharge Qs". The wording was corrected and double-checked.

R2: Page 7, line 16: what is a locally made abacus and how does it work?

Reply: In the ANRH protocol, the flow is generally measured with a winch by gauging a section over 5–8 verticals with between 2 and 6 measurements per vertical. At night, during holidays, or during some floods, the discharge is derived from a limnimetric height using a local stage-discharge relationship or abacus (see Achite and Ouillon, 2007, Journal of Hydrology). The local stage-discharge relationship or rating curve has been derived from the limnimetric heights and the river flows measured by the winch at the station, and is regularly updated. The word "abacus" was removed and replaced by a "stage-discharge relationship".

R2: Page 8, line 14: A subdivision of what exactly?

Reply: This paragraph refers to the choice of adjacent categories (or bins) of the discharge histogram. The title was revised into: "Relevance of a subdivision of discharges".

R2: Page 9, line 8: what flow frequencies are being referred to? Annual, daily, instantaneous, all of them?

Reply: This refers to instantaneous discharges measured at the gauging stations. However, a left skewed distribution may also be observed with other short-term (e.g. hourly, daily) discharge values. The sentence was completed following: "Probability density functions representing flow frequencies from instantaneous values are left skewed distributions"

R2: Page 9, line 9: What is meant by 'irregular flow'

Reply: This refers to semi-arid environments, where streams/wadis may encompass long periods of nil or very small discharge. The sentence was modified into: "However, for irregular flows as encountered in semi-arid environments with long low flow periods, more pronounced asymmetric distributions are recommended."

R2: Page 9 line 10: No results for the exponential distribution are included in this study?

Reply: The reference to the exponential solution was removed from the paper. To complete your information: we developed and calculated the statistical solution for the exponential distributions. The deriving discharge probability density function of flow frequencies was only acceptable when we used a subdivision of flow classes of equal length 6 or 8 m3/s. These subdivisions were, however, not retained in this paper since they do not check the selection criteria of the modal class. The subdivision of discharges into classes in geometric progression did not provide a suitable adjustment to the exponential distribution.

R2: Section 3.7: I don't think this section is necessary

Reply: This study showed that, in the Wadi Sebdou, the half-load discharge (29.8 m3/s) 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.”

Additionally, we showed in the last subsection of the discussion that the half-load discharge calculated over two hydrologic periods (1973-1988 and 1988-2033) was very close to the effective discharge of each period, making it a robust proxy of the effective discharge. This result fosters further warrants in future studies and in other basins. A short paragraph was added at the end of the discussion.

R2: Page 11, line 8-11: I don’t understand this sentence. What is QT99, and what is meant by ‘1% of the annual time’? Is this based on analysis of annual maximum data, or all daily flow data? Also, there is a reference to Fig.2 but I have no idea from the text what I am looking at in that Figure. More explanation is required here.

Reply: The quantiles are presented at the end of the subsection “Elementary contribution and budgets”. The instantaneous discharge is in average higher than QT99 during 1% of the time each year (i.e. 87 hours and 40 minutes). QT99 calculation is based on all elementary contributions of flow during 31 years of measurements (40,081 data, as detailed in the “Data pre-processing” subsection, i.e. around 4 values per day, in average). The link with the figure 3 (former Fig. 2) is the following: QT99 is directly readable on the curve of the cumulative time duration assigned to ordinal discharges; it is the abscissa of the cumulative curve when its ordinate is 99%. You can check as well on the figure that QT90=1.54 m3/s, which means that 90% of the year, in average, the instantaneous discharge is lower than QT90. The paragraph was rewritten.

R2: Finally, this section used QY for sediment (check units in line 16, page 11) rather than QS as on page 3.

Reply: QY refers to a water discharge (in m3 s-1, and such that QYx is the water discharge below which x % of the cumulative sediment yield was brought by the stream) while Qs refers to a sediment discharge (in mass of suspended matter per unit of time). Units in line 16 page 11 are thus good. However, your remark is very instructive, since the scientific community use alternatively QY50 or QY1/2 for the same parameter (the half-load discharge or the mean discharge in terms of sediment yield). To be consistent all along the paper with the subsection "Elementary contributions and budgets", QY50 (i.e. the water discharge that delimits 50% of the cumulative sediment yield) was preferred to QY1/2 in the revised version of the paper.

R2: Page 12, line 3: From the description in the text I am not sure what I am looking at in Figure 3. Please try to be more helpful to the reader.

Reply: Thank you for this remark. We changed the second sentence according to: "As can be seen on the histogram of sediment yields (Fig. 4), the class which induced the highest sediment contribution (the dominant class), [29; 30 m3 s-1[, brought 4.8% of the total sediment supply. This class represents 0.51% of the total water supply (Fig. 4) [. . .]"

R2: Section 4.2: This headline is not very helpful in describing what is the content of this section.

Reply: The headline was changed and replaced by: "Analytical determination of the effective discharge" (title of 4.3 in the revised paper)

R2: Page 17, line 8: Qs, but should that be QY?

Reply: While the calculation of the effective discharge by the mean approach makes use of the elementary contributions of sediment supply (thus introducing QY), the analytical approach makes use of the probability distribution of instant parameters. We referred to the Wolman and Miller's presentation of the analytical method who introduced g(Q), the rating curve estimating the suspended sediment flux Qs as a function of the water discharge (see Introduction and Fig. 1).

R2: Figures 7 and 8: The layout of these two figures is different and it would be better if they had a more uniform look. For example, remove gridlines from Figure 8, add y-axis label on Figure 7.

Reply: Done.

Please also note the supplement to this comment:
https://www.hydrol-earth-syst-sci-discuss.net/hess-2018-189/hess-2018-189-AC2-supplement.pdf

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