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Robustness and applicability of metrics for characterizing first flush effect during floods in temporary streams

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First flush effects are most of the time addressed in urban hydrology; however they are even more marked for Mediterranean intermittent rivers, even in rural contexts. A first flush effect is normally defined as a disproportionate increase of particulate or dissolved materials in terms of concentration or load in the rising limb of a runoff event. In Mediterranean context, such effect is observed during flash floods generated, after long-duration dry periods, by intense rainfall events: the runoff on hillslopes and the rewetting of the river course flushed particulate material and the attached contaminants to the outlet, causing significant first flush effects. Various metrics are proposed in the literature for characterizing first flush effects. All of these metrics are based on the normalized cumulative load-volume plot (NCLV plot), i.e. normalized cumulative loads of a given water quality parameter versus normalized cumulative flows along the flood, which requires the calculation of the total flood volume and the total flood load. Since discharge measurements are practically continuous, while concentration data are sporadic, and the sampling frequency is low during a flood, various questions arise. The first set of questions concerns the method used for calculating cumulative and total flood loads and is linked to sampling frequency: do the NCLV plots evolve when changing the sampling frequency or the load calculation method? how to reduce the error? The second set of questions concerns the flood volume and the duration of the flood. The last set is focused on the water quality parameter and the link between particulate contaminant and first flush effect. All these issues were addressed on water quality data collected during floods in a small intermittent Mediterranean catchment: the Vène (67km^2, France). Various water quality parameters were tested: particulate contaminants i.e. coliforms, streptococcus, particulate phosphorus, ash free dry mass, trace metals, and dissolved contaminants i.e. nitrates, soluble reactive phosphorus. Among all the results, it was observed that (1) NCLV plots strongly depend on the method used for calculating loads, inducing large differences in the intensity of first flush effects estimated by the various metrics ; (2) the duration of the flood has a low impact on the plots, once the duration is longer than the rising limb; (3) for a given NCLV plot and a given parameter, the intensity of first flush effect is different depending on the metrics used. Moreover differences between the estimated intensities are larger for dissolved contaminants than for particulate ones.