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Drinking Water Engineering and Science Discussions

Interactive comment on "Low-cost multi-stage filtration enhanced by coagulation-flocculation in upflow gravel filtration" *by* L. D. Sánchez et al.

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Dear Caetano, we appreciate your interest in this topic and your review of the work, as well as the comments and input references. Responses to the comments are listed below:

Comment 1: Sánchez et al. (2012) have revisited the topic of direct (or contact) gravel filtration and have presented results on its full-scale application. The results clearly demonstrate the higher treatment efficiencies obtained when resorting to the use of coagulants to enhance the performance of the upflow gravel pre-filters. These results are largely in line with other studies on this form of pre-treatment for slow sand filters (e.g. Ahsan, 1995; Ingallinella et al., 1998; Mahvi et al., 2004; Dorea and Clarke, 2006a; Ahn et al.2007; Khan and Farooqui, 2011). However, one important aspect of

this topic escaped their examination.

Response: reviewing the topic is relevant, in the paper is shown that the combination of coagulation-flocculation processes combined with multi-stage filtration is an alternative that can be sustainable by small community at rural scale. There are experiences in the literature regarding these treatment alternatives done in laboratory and pilot studies but few documented experiences of this technologies implemented at full scale.

Comment 2: I agree with Reviewer #1 that the Discussion of results has scope for expansion (and clarification); particularly with regards to the protective effects of such pre-treatment on slow sand filtration performance. The goal of pre-treatment is to lessen the contaminant load on downstream slow sand filters and also protect them from premature "clogging" (i.e. excessive headloss due to particulate loading). Sánchez and colleagues have cited a previous study (Dorea and Clarke, 2006b) in which it was demonstrated that without a careful control of the coagulation step, the coagulant-enhanced pre-filtration is actually detrimental to slow sand filter protection even though turbidities of less than 10 NTU are achieved. That is, overall treatment was better, but the aluminium hydroxide precipitates caused a higher headloss development in the (coagulant pre-treated) slow sand filters than the control filters (without coagulant). Despite the control filters having received an influent with turbidities many times higher than the 10 NTU design rule-of-thumb. However, this significant finding was largely ignored in their Discussion.

Response: Thank you for your observation, this allows us to clarify little more this point. Precisely to prevent the coagulant to be transferred to the SSF, we have developed the CFUGF unit independently. This allows better control of coagulation and flocculation, but also prevents future problems of maintenance with the UGF unit because the coagulant is no applied directly on it. The system described here has been operating properly for over 7 years, The filters has not shown the problem that you mention, and the SSF units are not clogged, the results per se are valid for the time of operation. We don't have evidence that aluminum precipitates causes high development of head loss

in SSF, but we are thinking in the possibility to develop further studies on the behavior of aluminum and other coagulants at different stages, but these additional research will be for the future. In this particular experience, the use of coagulant is intermittent and it is an advantage in terms of cost and operation and maintenance.

Comment 3: this sort of analysis is essential in order to validate and bolster the significance of their results on a full-scale system. From what can be gathered, Sánchez and co-workers did make aluminium residual and turbidity determinations as well as (slow sand filtration) headloss measurements. Thus, a critical evaluation of the protective effects of such intervention (i.e. coagulant-enhanced pre-filtration) can be performed. Here, they may find that aluminium residuals (coupled with pH) are a key parameter. In that sense, their aluminium residual results could benefit from stating in which fraction was being measured (i.e. total or dissolved/filtered aluminium) in the Materials and Methods. Moreover, their chosen method of for aluminium analysis (i.e. Eriochrome Cyanine R Method) is known to suffer from interference from polyphosphates; underestimating actual concentrations. Given that the rural study area is under a heavy influence of (apparently non-optimal) human activity, the presence of such an interferent is a plausible concern.

Response: we don′t have evidence of the presence of polyphosphates in the source, but we think that this is an important topic for other research works, giving continuity to the development of this study.

Comment 4: I also agree with Reviewer #1 that some of their figures are confusing, particularly with regards to turbidity. Fig.6 and 7 are not very clear (i.e. colour choice does not permit a good visualisation). Differences between operation with and without coagulants would possibly be best demonstrated on a side-by-side comparison format. Overall, the “over descriptive” nature of their results undermines their importance. Better use of tables and graphs could yield a better and clearer contribution.

Response: See comment of reviewer # 1. Fig 6 and 7 will be enhanced.

Interactive comment on Drink. Water Eng. Sci. Discuss., 5, 291, 2012.