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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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Response to the Short Comments A. Araya

We really appreciate your comments and your dedication to the revision of the work. Responses to comments are presented below:

Comment 1

The article assesses the operational and design aspects of coagulation and flocculation in upflow gravel filters (CF-UGF) in a multi-stage filtration (MSF) plant. It is encouraging that authors regarding these treatment alternatives, execute at them full scale, as it has more practical value for the greater audiences. The paper is clear in the introduction, methodology and results section.

Answer 1

Thank you for your appreciation. Full scale assessments are important in our view, but require more time and resources. So we very much agree with you and considered this analysis particularly relevant to explore how O&M conditions are preserved over time and to analyze how to ensure sustainability of small systems which use coagulants.

Comment 2

It is important to acknowledge that Multi-Stage Filtration (MSF) is one of the more promising and reliable water treatment options for small communities. The authors state that the major advantage is the flexibility of the system to operate with and/or without a coagulant agent, according to the influent turbidity using "CF-UGF".

Answer 2

This is indeed an important characteristic of the system, but to ensure good performance it is crucial to know the behavior of the water source during the dry and rainy season. This is necessary to make a good design and establish the number of stages of UGF after CF-UGF unit to ensure proper operation of the SSF, and define the dose of coagulants

Comment 3

I am a professor at Instituto Tecnológico de Costa Rica, one of four state universities in this country. Particularly, in Costa Rica the situation is alarming; with nearly 179,000 people in the country consume water from streams and rivers exposed to pollution, specifically in 273 surface water sources which have not yet implemented any kind of treatment in operation. Additionally, we have many "slow sand filters" operating without pretreatment, despite the fact that we are a country with constant and intense precipitation and therefore, turbidity spikes are common. This causes high contaminant loads and premature "clogging", forcing close-ups or generating operational failure in the filtration systems. The mistake has also been made of building complex cycle-

systems in places where there is no technical and economic capacity to operate them properly. As an alternative to this situation, (MSF) and CF-UGF are considered promising. Although much has been discussed in Costa Rica that would ideally implement coagulation and flocculation in rural systems, often leaving the initiative by the limited technical capacity of personnel operating the plant and the difficulty or economic limitations about buying chemical inputs. For the case of the community of Colinas de Arroyo Hondo, it was only necessary for 20 % of the time to operate with the coagulant finding the CF-UGF unit represented 7 % of total construction costs and the O&M cost for the use of coagulant represented only 0.3 %, demonstrating the usefulness of this type of improved technologies with the potential to adapt to our local context. Excellent contribution.

Answer 3

Thanks for your comment. A process of research and transfer to the rural sector to overcome the huge challenge of ensuring water quality can useful. This type of technology option can be helpful, but is not a panacea and specific conditions in each location must be analyzed before application.

Comment 4 The CF-UGF has 4 layers of gravel bed and was designed as a truncated pyramid to facilitate variation in the velocity gradient, producing a variable 15 gradient from the highest to the lowest value, but this lowest value is not particularly clear. See Table 4. The dimensions of CF-UGF are 2m x 2m for 3 ls-1 but the filtration rate that appears in Table 3 is 3.2 but really gives 2.7?. The same goes with UGF unit, the dimensions are 3.8m x 2.8m for 3 ls-1 but the filtration rate that appears in Table 3 is 0.9, but really gives 1.2?.

Answer 4

Thanks for the clarification and revision. Effectively the area of CF-UGF units is 4 m2 and not 2.1 as shown in Table 3, was a typing error, the area of UGF is 10.8 m2, the actual dimensions are 3.8 m and 2.84 m, the difference occurs basically by a single

decimal approximation. The speed of UGF is 1.0 m/h, corrections were included in Table 3; but the filtration velocity in CF-UGF unit varies between 3.2 to 27 m/h, Vf in the CF-UGF unit correspond to the average between layers of gravel. We will include corrections in Table 3.

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