

## ***Interactive comment on “ Modelling the hydrological behaviour of a coffee agroforestry basin in Costa Rica” by F. Gómez-Delgado et al.***

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We appreciate the constructive reviews from the anonymous referee 2. All the technical comments and corrections will be incorporated to a revised manuscript. The general and specific comments are replied in the same order they were stated by the referee.

### **General comments: Anonymous Referee 2**

*“The paper is based on important field studies, is thorough, well worked out and well researched, and certainly deserves publication. Indeed, it could be discussed whether*

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*it advantageously could have been split in two publications, one concentrating on the field studies and measured water balance, and one on modelling.”*

The authors: we thank the encouraging opinion of the referee about our paper. Concerning the splitting into two separate publications, we consider that the method we have proposed, combining measured and modelled water processes, is better explained in a single comprehensive paper, like the one we are currently discussing. This combination of techniques was the starting point for our paper, and supports the presentation and discussion of the results. Therefore, we consider that a successful separation of this into two standalone papers would be a difficult task to achieve.

*“The coupling to Hydrologic Environmental Services is a bit problematic, as neither the field study nor the modelling has direct applications in an HES context. There is no paired catchment with other AF practises (or "natural" conditions),...”*

The authors: we totally agree we might be inducing to confusion about concepts like Hydrological Environmental Services (HES), Payment for Environmental Services (PES) or payment for HES. In order to clarify this misunderstanding, we will give some short definitions. Then we will point to the ambiguities that we found in our text, to finally propose some corrections that may improve the understanding of the purposes of this study. The concept of HES is different from that of PES, or payment for HES. While the first is more generic, and deals with the positive effects of a hydrological system on environmental variables, the other two are linked to the financial retribution to land owners for adopting or maintaining specific management practices. For instance, in the introduction of this paper we explain (3017/9-10) that “the ability of ecosystems to infiltrate rainfall, sustain aquifers, and avoid erosion is a key determinant for the provision of hydrological environmental services”. This is the definition of HES that we have in mind throughout the entire paper. Then we add (3017/24-25) “. . .the eventual trade-offs of the payment of HES from hydropower producers to coffee

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farmers become evident”. Here we explain that HES might be financially recognized through a payment from one productive sector to other. To conclude this short explanation, we quote (3017/25-27): “Negotiation for these payments is facilitated between providers and purchasers when the service, or the impact of a given practice on the provision of the service, are clearly evaluated”. Here we present two different types of services, those provided by a given system (like a natural forest) and those by human practices (like agroforestry). However, in (3017/12-16) we say “woody plants and in particular agroforestry systems associating shade trees and perennial crops with deep root systems are assumed to enhance these HES in comparison to traditional intensive cropping systems (Ataroff and Monasterio, 1997; Vaast et al., 2005; Siles et al., 2010), but it is crucial to verify and quantify this hypothesis.”. Although this sentence is not saying that we aim to verify such a hypothesis, this creates confusion about the intention of our analysis, which is definitely not to demonstrate the difference between agroforestry and intensive cropping. We propose to completely reformulate this paragraph, deleting the idea of comparison to intensive cropping and of the verification of any related hypothesis.

*“...and the model has no parameters that relate directly to AF practises, vegetation cover or other relevant field parameters that would make the model a natural choice for predicting changes in relevant HES variables (streamflow, erosion) under varying AF practise.”*

The authors: we consider that LAI (a forced input parameter), and the parameters of maximum crop coefficient ( $r_m$ ) or canopy storage capacity ( $A_X$ ) are very linked to the vegetation cover (eventually under agroforestry practices), as well as the maximum soil infiltration capacity ( $f_0$ ), which is affected by the root systems and litter production by coffee plants and shade trees. LAI as a time-dependent input variable, is strongly determinant in the regulation of the simulated actual evapotranspiration and, of course, it is a direct function of the specific vegetation cover in the basin and of the pruning

practices that can vary a lot in coffee management (selective pruning, pruning by line, top pruning etc.).

## Specific comments: Anonymous Referee 2

*“The model algorithms take much space in the paper, and could be considered organised in an annexe.”*

The authors: we are completely open to discuss this possibility.

*“Uncertainty and sensitivity analysis is addressed at two separate places in the paper (3.3, 5.1.2 and 5.1.3) - it could be considered to combine these sections.”*

The authors: while section 3.3 is a methodological description of those analyses, sections 5.1.2 and 5.1.3 are discussions based on results, so if the referee agrees we would prefer to keep them as independent sections.

*“In 5.2.3 estimated evaporation is compared with other studies in terms of percentage of rainfall. It would be more relevant to discuss this in absolute values (mm/y).”*

The authors: all the water balance components were presented as a percentage of rainfall to facilitate the comparison of the relative weight of each component in every environment and between environments. If the referee considers relevant to present the absolute value of evapotranspiration, we could include it in brackets in Table 4.

*“As indicated above - the opinion of this referee is that section 5.3 could be dropped from the paper, alternatively some of it could be incorporated in the general description*

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*of the catchment. To the extent that the connection between agroforestral practices and HES is discussed in this section, it is not founded on neither the field study data nor the modelling results.”*

The authors: we reiterate that the HES to which we refer here deal with the effect of the entire coffee agroforestry system under particular conditions (e.g., climatologic, biophysical, geological) on the basin hydrological processes, and not with the effect of agroforestry practices in comparison to other land uses.

### **Main technical comments and corrections: Anonymous Referee 2**

*“Figures: Figs 5, 7 and 10 will be hard to read and interpret. One way to improve them would be to just display part of the time period, by selecting a representative/interesting couple of months the graphs would be more readable and carry more information (in particular on the performance of the model during the sharp flood peaks).”*

The authors: we propose to add this “two months” window next to each of the annual graphs already presented in Figs 5, 7 and 10.

*“3042/19: The Kolmogorov-Smirnov test revealed that the distribution of residuals is not normal (which is not desirable). Drop (which is not desirable) - it is ambiguous, and anyhow modelled runoff residuals for small catchments are never normal - desirable or not.”*

The authors: we will drop “(which is not desirable)” in the revised manuscript.

*“3021/27: but showed a monthly deviation of +/-100 mm around the historical regime. According to the fig 2 the deviation is up to 250 mm.”*

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The authors: the referee is right. The maximum deviation is +251 mm in February and our sentence is wrong. As the absolute monthly anomalies (in mm) are: [20, 251, 99, -63, -104, 106, 85, -8, -98, -128, 129, -87] and the absolute values of these anomalies have a mean of 98 mm, we propose to rewrite the sentence as “. . .but showed a monthly average deviation of  $\pm 100$  mm around the historical regime”.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 3015, 2010.

**HESD**

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