Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2020-2-AC1, 2020

Hydrology and Earth System Sciences Discussions

Open Access

HESSD

Interactive comment

Interactive comment on "Infiltration-Friendly Land Uses for Climate Resilience on Volcanic Slopes in the Rejoso Watershed, East Java, Indonesia" *by* Didik Suprayogo et al.

Didik Suprayogo et al.

suprayogo09@yahoo.com

Received and published: 17 May 2020

1. General comment

Comment 1 The paper by Suprayogo et al. describes the results of a short-term (ca. two months) ïňĄeld experiment aiming to identify which of the dominant land uses in the middle and upper parts of the 633 km2 upland Rejoso catchment in the volcanic uplands of East Java may be considered 'inïňĄltration-friendly' under the prevailing rainfall intensities.

Feedback comment 1 Yes, we do agree. In the Rejoso watershed, degradation has

Printer-friendly version

Discussion paper

become an issue and land use on the slopes is suspected to be one of the causes. Practical answers are needed

Comment 2 In addition, the study seeks to identify which readily measured vegetation and surface characteristics may be used to deïňĄne the critical threshold values associated with such 'inïňĄltration-friendly' land uses.

Feedback comment 2 That is right, we stated in line 43-64

Comment 3 The rationale for this work partly us in an observed decline in the quantity and quality of water resources in the study area believed to reïňĆect changes in land use and land cover in the Rejoso basin as well as increased extraction of groundwater for irrigated rice cultivation in the lower parts of the catchment.

Feedback comment 3 Yes, some video's explaining the situation are available was made by Danon

Comment 4 The authors rightly point out that much of the debate on land cover and catchment water yield and/or stream-ïňĆow regimes focuses on forested versus agricultural uses of the land, whereas preciously little is known on the comparative ability of such 'intermediate' land-use types as agroforestry systems in terms of maintaining soil inïňĄltration capacity, groundwater recharge and dry-season ïňĆows under seasonal tropical conditions (Toohey et al., 2018; Nespoulos et al., 2019).

Likewise, most global reviews of the literature on 'forests and water' have concentrated on the changes in total water yield associated with forest removal or addition, interpreting the observed changes in ïňĆow primarily in terms of increases or decreases in vegetation water use (evapotranspiration, ET) as a function of forest type or climate, but leaving the effects on ïňĆow regime by potential changes in surface conditions essentially non-analyzed (e.g. Zhang et al., 2017; Filoso et al., 2017; Bentley & Coomes, 2019). Only a few studies have paid explicit attention to changes in seasonal streamïňĆow regime after removing or adding trees (e.g. Lane et al., 2005; Brown

Printer-friendly version

Discussion paper

et al., 2013; cf. Van Noordwijk et al., 2017ab). In view of the fact that such changes in streamïňĆow regime will reïňĆect both changes in ET and in inïňĄltration after the change in land use under given climatic conditions (Bruijnzeel, 2004; Peña-Arancíbia et al., 2019) the paper by Suprayogo et al. is to be welcomed in principle in that it documents inïňĄltration (at the runoff plot scale) and erosion rates for a series of agroforestry systems (both terraced and non-terraced), rain-fed crops (mostly maize) and forest plantations (pine and mahogany) that may be considered typical for Java's densely populated uplands.

Feedback comment 4 In the Rejoso watershed, the main issue that occurred was land cover changes from forest to agricultural uses and had a very significant impact on catchment water yield and / or stream flow. The function of agroforestry as a trade-off between production needs and watershed buffer hydrology has not been much studied in the tropics. This research study is unique to contribute knowledge of how agroforestry systems in terms of maintaining soil infiltration capacity, groundwater recharge and dry-season ïňĆows under tropical conditions. For that, thank you for your comment on this research novelty.

Comment 5 Moreover, the paper marks a valiant attempt at identifying some of the key vegetation and surface characteristics controlling inïňĄltration rates, runoff production (i.e. overland ïňĆow) and surface erosion rates using low-cost / low-tech approaches for measuring rainfall, runoff and site characteristics.

Feedback comment 5 This is true, that we designed research equipment using low-cost equipment and simple equipment, but we design it by following the principles of a measurement approach that can be scientifically justified. This is done with the consideration that the measurement is done in a remote location. With the low cost equipment, we do hope that will not attract the attention of the surrounding community about equipment that has low economic value, so it is safe not to get damage or vandalism from one or two irresponsible community members.

Comment 6 The paper's key ïňĄndings include strongly negative relationships between canopy cover fraction and either plot-scale runoff coefïňĄcient (Fig. 6) or surface erosion (Fig. 7), and to a lesser extent between the latter and surface litter amounts while understory biomass seems less important. However, individual land-use types deviated from this general pattern. For example, the 'young' and 'old' production forest plots (UT1 and UT2) had the same runoff coefïňĄcients (13-14%) but the young forest exhibited a far smaller soil loss than the older forest, despite having a more open canopy (by 12%, difference not signiïňĄcant), a much lower litter mass (2.0 vs. 9.2 t ha-1) and a much steeper slope (50-60% vs. 30-40%) (Tables 3 and 1). Likewise, agroforestry plots MT2 and MT3 exhibited the same (high) runoff coefïňĄcient (37-38%) but differed by a factor of 2.3 in soil loss with the amount of litter on the ground being the same (Tables 3 and 1). Such ïňĄndings suggest that soil characteristics (as opposed to surface or vegetation variables) likely play a role as well and perhaps deserve to be included in any predictive equations (e.g. SOC?; applicable in the case of MT2 vs. MT3 but not for UT1 vs. UT2 (Table 2)) (Table 2)). At any rate, it would be good to include such considerations explicitly in the Discussion section.

Feedback comment 6 Thank you for the novelty's emphasis on this research. We use these comments to revise the descriptions in the results and discussion.

Comment 7 On the downside, the paper gives the distinct impression of having been put together in some haste and the often highly concise text leaves much to be guessed (or derived) by the reader. This holds especially true for the sections describing the study area and methods, but also for the Results and Discussion. For example, the study area description effectively consists of a Table describing the landcover types for the eight examined locations (Table 1) but fails to give basic location or climatic information, or a proper description of vegetation characteristics (e.g. tree height – important to assess the erosive power of crown drip) or the nature of the terraces of the mid-stream research plots (notably whether the plots included terrace risers or terrace beds only).

Feedback comment 7 The basic location we will give description as suggested in specific comment no 12. The basic climate information, we have daily data for up-stream and mid-stream for long term period (12 year). We will presenting the average data for this period at monthly basic within a year period. Regarding the description of vegetation characteristics, we measured the tree height and we will presenting into this manuscript. We presenting the tree height in Table 1 in supplement note no 1.

The nature of terraces is considered as bench terrace sloping outward. The measurement of runoff and soil erosion in the terrace bed and do not considered terrace riser.

Comment 8 As to the methods used, it is not clear – inter alia – in which plots 'rainfall' truly represents incident rainfall or rather crown drip (throughfall) (line 101); what size or type of funnel was used for the improvised rain gauges and what the catch efïňĄciency of these gauges was compared to that of a standard rain gauge (cf. Ghimire et al., 2017; Zhang et al., 2019); how the collection drums with a stated capacity of 30 cm3 (!) (Fig. 2) could accommodate the runoff produced by 12 m2 plots with runoff coefïňĄcients of up to 41-64% (Table 4); how coarse sediment eroded from the plots was accounted for or what the effect of ïňĄltering runoff samples through 'newsprint' (lines 111-112) was on the magnitude of sediment concentrations obtained compared to more conventional ïňĄltration methods; how particle density was determined (line 124); or how many replications were used to determine undergrowth or litter mass (lines 140-141), etc.

Feedback comment 8 We measured throughfall by using simple rain-gauge with mineral bottle combined with 30 cm diameter of plastic funnel. This diameter funnel is considered standard of rain gouge. Therefore, We do not measured catch efficiency. Each plot, we installed 5 rain-gauge randomly.

Two collection drums with a capacity of 30 dm3 (was not 30 cm3) was used to collect the runoff and sediment, where the first drum was channeling into 13 channel PVC pipes with equally hole size and the levelling position and one of others connected with second drum. The volume of water come out from each hole we calibrate to get the water volume proportion enter into second drum. The potential capacity of the runoff collector then can be = (25 dm3 * 13) + 25 dm3) = 350 dm3. If the plot size by 12 m2 and assumes all the rainfall become runoff then this runoff collector can collect = 350 dm3/1200 dm2 = 0.292 dm = 292 mm rain event.

The course sediment was trapped in first drum. During the sediment sampling, the sediment and water in each drum was stirred homogeneously and then take one liter of sediment samples. We filtering the sediment sample using 'newsprint'. The water through a filter 'newsprint' was relatively clear. Therefore, we consider that 'newsprint' filter is considered effective to trap the sediment. We do not calibrate between 'newsprint' filter with standard filter. The particle density was measured by using pycnometer method.

We use this scheme below (presenting in supplement note 2 to measure the undergrowth or litter mass. This scheme based on based the protocol by Hairiah K, Ekadinata A, Sari RR, Rahayu S. Measurement of Carbon Stock: from land level to landscape. Practical instructions. Second edition. Bogor, World Agroforestry Centre, ICRAF SEA Regional Office, University of Brawijaya (UB), Malang, Indonesia 110 p.[Indonesia] http://apps.worldagroforestry.org/sea/Publications/files/manual/MN0049-11.pdf. 2011

Comment 9 Ibidem for the Results section: e.g. the main results for soil properties are described in 1.5 lines only (lines 162-163);

Feedback comment 9 The two soil groups chosen to represent "InïňĄltration-Friendly" Land Uses, namely Inceptisol and Andisol do have different characteristics. We have soil texture every 10 cm soil depth at a depth of 00-50 cm. The bulk density, particle density, porosity macroporoity and soil orgnic mater observations every 10 cm soil depth at a depth of 00-30 cm from the surfaces, showed that the two soil groups have deep soil profiles. The striking difference between the two soil groups is finer soil texture, higher bulk density, lower macro-porosity and lower soil infiltration in the Inceptisol than in the Andisol. The data we presented in supplement Note 3, and we will added those data and give more comprehensive description and discussion related with the soil characteristic to answer the first research question.

Comment 10 key Tables 2-4 give averages or period totals only but no standard errors or coefïňĄcients of variation as a measure of within-plot variability despite the fact that the large variation in rainfall (throughfall?) totals between adjacent (?) plots (e.g. 300 mm for plots MT4 and MT2 in Table 4) suggested major spatial variability;

Feedback comment 10 Regarding Tables 2-4 we used Fisher's LSD test ($p<0.05$). to represent the standard errors or coefïňĄcients of variation.

Comment 11 The captions to key diagrams 4 and 5 which count 8 panels each do not explicitly specify which panel refers to which plot in any descriptive way other than their relative position in the list of plots in Table 1.

Feedback comment 11 We revised as follow: Figure 4. The relationship between surface runoff / rainfall ratio and the amount of rainfall in production forest and agroforestry systems in (a) Upstream Rejoso Watershed, under (a.1) 55% canopy cover of Pine based of old production forest, (a.2) 40% canopy cover of Pine based of young production forest, (a.3) 5% canopy cover of Cemara based of Agroforestry with Cabbage crop, (a.4) 0% tree canopy cover of Arable land (maize crop) ; (b) Midstream Rejoso Watershed under (b.1) 87 % canopy cover of Pine/ mahogany based of old production forest, (b.2) 75% canopy cover of Coffee-based agroforestry, (b.3) 52 % canopy cover of Clove based agroforestry, (b.4) 26% canopy cover of mix tees-crop based agroforestry.

Figure 5: Soil erosion in relation to daily rainfall rates in production forest and agroforestry (a) Upstream Rejoso Watershed, under (a.1) 55% canopy cover of Pine based of old production forest, (a.2) 40% canopy cover of Pine based of young production forest, (a.3) 5% canopy cover of Cemara based of Agroforestry with Cabbage crop, (a.4) 0% tree canopy cover of Arable land (maize crop) ; (b) Midstream Rejoso Water-

shed under (b.1) 87 % canopy cover of Pine/ mahogany based of old production forest, (b.2) 75% canopy cover of Coffee-based agroforestry, (b.3) 52 % canopy cover of Clove based agroforestry, (b.4) 26% canopy cover of mix tees-crop based agroforestry.

Comment 12 The Discussion section is rather basic and does not address such critical issues as the improvised nature of the rain gauges and the neglecting of stemïňĆow as a possible input of water to the soil (which would lead to under-estimation of 'rainfall' and hence over-estimation of runoff coefïňĄcients), as well as the scale and ability of the plot-based measurements to represent the entire hilllslope's hydrological functioning (see below for details and related issues)).

Feedback comment 12 Thank you for the emphasis on this issues. We will use these comments to revise the descriptions in the results and discussion.

Comment 13 Furthermore, the reference list – although remarkably up to date with more than 60% of cited references published between 2017 and 2019 – misses at least six references that are cited in the text and contains another six that are listed all right but do not show up in the text (see below under speciïňĄc comments).

Feedback comment 13 We have been revised as list the in supplement note 4

Comment 14 On a related note, rather than to refer largely to recent studies in such very different environments as the semi-arid loess plateau in China (Zhao et al., 2019; Liu et al., 2018 – erroneously referred to as Zhipeng et al., 2018) the paper would arguably have beneïňĄtted from the inclusion of related studies in the volcanic uplands of West and East Java for added perspective. Examples include the effect of trampling/footpaths on runoff production and erosion from upland ïňĄelds (Bons, 1990; Rijsdijk et al., 2007; cf. Badu et al., 2019); the role of terrace risers versus terrace beds vis á vis runoff and sediment production (Purwanto and Bruijnzeel, 1998; Van Dijk & Bruijnzeel, 2004ab); the potential role of stemïňĆow in the generation of localized inïňĄltration or overland ïňĆow (high stemïňĆow fractions reported for bamboo, bananas, shaded coffee, tall grasses and understory shrubs (Taniguchi et al., 1996;

Printer-friendly version

Discussion paper

Cattan et al., 2007; Siles et al., 2010; Friesen et al., 2013; González-Martínez et al. 2016)); as well as a more holistic discussion of the interactions between canopy cover fraction, understory, leaf litter and hydrological processes (Wiersum, 1985; cf. Prijono et al., 2014; even Coster, 1938) – not only in terms of amounts of water involved but also the erosive power of the rain / crown drip as a function of falling height and leaf type (Wiersum, 1985; Hall and Calder, 1993).

Feedback comment 14 Thank you for the enrichment of references in the discussion that further clarifies the conditions of the tropics. We will include these references in the discussion.

Comment 15 In contrast to what is stated in the paper (lines 209-211), rainfall interception does not reduce the erosive power of the rain. Rather, a tree canopy enhances it because of the typically larger drop size of crown drip compared to incident rainfall for terminal fall velocities (Wiersum, 1985), with broad-leaved species producing larger drops than do conifers (Hall and Calder, 1993). Likewise, the few measurements of throughfall intensities under humid tropical conditions suggest these to be very similar to those of incident rainfall (e.g. Hutjes et al., 1990). As such, the presumed effect on delaying the onset of overland ïňĆow (line 211) would seem rather negligible. Similarly, based on the lack of correlations with surface runoff or erosion (Figs. 6 and 7) the role of understory vegetation is considered to be minor.

Feedback comment 15 Thank you for expanding knowledge about the process of the role of canopy in controlling surface runoff and erosion. We will include this consideration in the discussion.

Comment 16 Yet Nespoulos et al. (2019) emphasized the importance of a well-developed understory for the development of macroporosity and preferential pathways in tropical plantations. In addition, the discussion could use a paragraph on the importance of including both inïňĄltration and total ET (not just interception loss) for a proper assessment of the effect of land cover on groundwater recharge.

Printer-friendly version

Discussion paper

Feedback comment 16 We have measurements of macroporosity (based on methylene blue infiltration patterns) data and we will add this to the manuscript. We will refer to this in the revised discussion.

Comment 17 Other points not considered in the Discussion include such aspects like (a) the need for an adequate number of throughfall gauges to quantify net precipitation beneath such spatially highly variable vegetation types as some of the studied agroforestry systems (cf. Holwerda et al., 2006; Zion Klos et al., 2014); (b) the role of auto-correlation in the presented relations between runoff coefïňĄcient (i.e. runoff/ rainfall) and rainfall, (c) the possible role of (high) short-term rainfall intensities as opposed to the presently used daily totals in determining measured amounts of surface runoff and eroded soil (cf. Wischmeier's EI30 index), (d) the effect of the small size of the runoff plots used (2 m x 6 m) on measured amounts of surface runoff vis á vis their representativeness for hydrological functioning at the hillslope scale (variations in slope steepness, reinïňĄltration on less steep foot-slopes in the case of the upper plots; cf. Stomph et al., 2002; Moreno-de las Heras et al., 2010), and (d) what might constituted a plausible value of 'tolerable soil loss' for the study area (Verheijen et al., 2009; cf. Bruijnzeel, 1983; see also speciïňĄc comment *22 below for a possibly locally valid estimate).

Feedback comment 17 Thank you for the enrichment of references in the discussion (a) the importance of the amount of throughfall gauges to quantify net precipitation, (b) the role of auto-correlation in the presented relations between runoff coefficient (ie runoff / rainfall) and rainfall (c) the possible role of (high) short-term rainfall intensity as opposed to the presently used daily totals in determining measured amounts of surface runoff and eroded soil; (d) the effect of the small size of the runoff plots used for understanding the hydrological functioning at landscape scales, (e) considering "tolerable soil loss" in the discussion. We will include these considerations and references in the discussion.

Comment 18 On the basis of the above considerations my recommendation for this manuscript can only be rejection in its present form but allow resubmission if the main points raised in the previous paragraphs can be addressed satisfactorily. After all, the paper addresses an important topic and new information on inïňĄltration behaviour of agroforestry systems is to be welcomed.

Feedback comment 18 Thank you for the enrichment of references in the discussion that further clarifies the conditions of the tropics. We will include these references in the discussion.

2. SpeciïňĄc comments

Comment 1 *1, Title: you may want to use inverted commas for 'inïňĄltration friendly' in the title as well.

Feedback comment 1 Using inverted commas's in the title would lead to:'Infiltration-Friendly' Land Uses for Climate Resilience on Volcanic Slopes in the Rejoso Watershed, East Java, Indonesia We considered this suggestion, but think that it will create more confusion that it solves. If the reader gets interested in what this term means, we invite them to read the abstract and paper in which it is explained.

Comment 2 *2, line 20: based on the time line in Figure 3 (6 March–1 May 2017) a period of nearly two months would be more accurate than 'three months'

Feedback comment 2 We quantified infiltration and erosion in three replications per land use category over a period of nearly two months (one-fourth of mean annual rainfall), with 6-13% of rainfall with intensities (51-100 mm day-1).

Comment 3 *3, line 21: strictly speaking, when using daily rainfall and surface runoff totals to obtain net inïňĄltration amounts one cannot refer to the latter as inïňĄltration rates.

Feedback comment 3 We related soil infiltration to plot-level characteristics across the land use systems and found statistically significant relations with . . .. . .(Note we replace instead of "infiltration rate" to become "soil infiltration")

Comment 4 . *4, line 24: ‘preceding water use’ is unnecessarily vague; suggest replacing by ‘soil moisture status’ because moisture values are governed by the interplay of rainfall/drip, evaporation and soil water uptake, not just vegetation water uptake.

Feedback comment 4 . . ...with tree canopy cover (likely based on combined effects of interception, soil moisture status and effects on soil), understory cover, amount of litter, and soil surface roughness.

Comment 5 *5, line 24: relations with understory biomass or surface micro-topographic variation were not strong or absent (Figs. 6 and 7).

Feedback comment 5 We related soil infiltration to plot-level characteristics across the land use systems and found statistically significant relations with tree canopy cover (likely based on combined effects of interception, soil moisture status and effects on soil) and amount of litter. The soil infiltration has found statistically significant with surface micro-topographic variation under forest-agroforestry systems (midstream), but has not under vegetable cultivation in steep to very steep lands. There is no significant relation between soil erosion and understory biomass of land use system.

Comment 6 *6, line 28: an average runoff coefïňĄcient of 62% (actually 64% in Table 4) is exceedingly high and more representative of compacted dirt roads and yards in the area than actively worked agricultural ïňĄelds (see e.g. Rijsdijk et al., 2007). Such high values might suggest rainfall inputs may well have been under-estimated. Worth checking!

Feedback comment 6 For a tree canopy cover in the range 20-80%, erosion rates were relatively low, but surface runoff increased to 36 to 64% of rainfall. Differences in soil type influenced the thresholds, as the areas’ Inceptisols have lower intrinsic porosity than Andisols. However, we check again the data.

Comment 7 *7, line 29: with porosities of 55-62% and bulk densities of 0.9-1.1 g cm3 (Table 2) the soils of the mid-stream sites are not particularly dense. Rather, one would think of crusting or slaking as a potential cause for low apparent inïňĄltration?

Feedback comment 7 The data of soil Bulk Density that we presented was a top soil data. Forest or agroforestry land use in mid-stream can provides input of organic material and then can have relatively high microorganism activity. This such condition can stimulate low soil bulk density values. Infiltration in the mid-stream is low because the subsoil layer has a fine texture and high bulk density. To prove this, we added data not only on top soil layers but also sub-soil and infiltration data measured with a double ring infiltrometer.

Comment 8 *8 lines 41-42: this sentence seems to fall out of the blue; since the cited reference concerns a global review of the literature on surface erosion it might be possible that the authors meant Wiersum (1985) instead which documents the role of understory and litter layer with regards to surface runoff and erosion in an Acacia auriculiformis plantation in West Java, not pines. Incidently, drip from a pine canopy is less erosive than that from broad-leaved species like Eucalyptus and, especially Teak (Hall and Calder, 1993).

Feedback comment 8 Thank you for your note. We will revised on this part

Comment 9 *9, line 52: the sentence on inïňĄltration recovery seems out of place here and had perhaps better be moved to the Discussion section.

Feedback comment 9 Thank you for your note. We will moved to discussion section.

Comment 10 *10, line 54: whilst the inïňĆuence of a very extensive and aerodynamically trough forest cover on rainfall may have an effect on downwind rainfall amounts (as opposed to 'events'), it would seem inappropriate to mention this in the present context of on-site water dynamics. Suggest to leave out this aspect.

Feedback comment 10 Thank you for this comment. We will leaved out this aspect.

Comment 11 *11, lines 62-64: unclear why Climate Resilience is written with initial capitals?; also, relation between ïňĆow persistence metrics and peakïňĆow transmission (routing? percolation?) is not instantly clear.

Feedback comment 11 In watersheds that provide a perfect buffering river ïňĆow might theoretically be constant every day, but in practice a 'flow persistence' metric of about 0.85 is hard to surpass (van Noordwijk et al., 2017). Flow buffering is essential for Climate Resilience (Aduah et al., 2017; Shannon et al., 2019) and high flow persistence metrics are desirable, as they directly relate to peak flow transmission (van Noordwijk et al., 2017).

Comment 12 *12, lines 77-78: soil fertility and agricultural productivity may be maintained sufïňĄciently on these deep volcanic deposits even if surface erosion rates are high. Also, previous research on sediment production in similar terrain nearby in East Java (Rijsdijk and Bruijnzeel, 1990ab; Rijsdijk, 2005) has shown that contributions from rain-fed agricultural ïňĄelds made up a comparatively minor proportion of overall annual sediment yield at the operational catchment scale with roads, paths, settlements contributing signiïňĄcant amounts each.

Feedback comment 12 Thank you for your comment. The research of Rijsdijk and Bruijnzeel, 1990ab; and Rijsdijk, 2005, will be added in this part.

Comment 13 *13, section 2.1, Study area: suggest to give a proper basic description of site locations (place names, latitude, longitude, elevations) along with information on the main environmental conditions, notably (a) annual rainfall totals and the agro-climatic classiïňĄcation of the two main sites in terms of rainfall seasonality (e.g. Oldeman climate types D3 and C2 for the middle and upper zones of the catchment?), (b) prevailing rainfall intensities (e.g. based on the authors their own measurements or the iso-erodent map of Java ?, and perhaps (c) FAO reference evapotranspiration (to help assess the importance of differences in inïňĄltration relative to vegetation water use). Soil characteristics for the study plots are presented in Table 2 under Results but some general initial indication of soil types, their spatial extent in the catchment and their relative susceptibility to erosion (e.g. expressed as Wischmeier K-values?) would not go amiss here (instead of the scattered reference made to soil characteristics across different sections). More importantly, give information on the age of the tree plantations (plots UT1, UT2, MT1 and MT2) and the height of the trees (important for assessing the erosive power of the raindrops, see previous comments on Discussion section) as well as some indication of tree densities in the various agroforestry plots (MT2-4), the width of the Casuarina strips in UT3, etc., etc. Likewise, photos of the respective plots could be added as Supplementary Material to give the reader a better impression, also in terms of plot sizes relative to terrace dimensions (were terrace beds back-sloping? If so, were adjacent upslope risers in plots MT1-4 included? (cf. Purwanto and Bruijnzeel, 1998); what was the nature of the terrace risers (grassed, weeds, stones?). NB: Table 1 still contains a number of plant names in Bahasa Indonesia (e.g. mahoni instead of mahogany) plus a number of typos (Albizia, manggo, dapap).

Feedback comment 13 We will revised as your suggestion. Some example revision will be as in supplement note 5.

Comment 14 *14, section 2.2 Rainfall: 'ombrometer' is an obsolete (colonial) term. Give dimensions of the rain gauge funnels and indicate whether these improvised gauges were calibrated against standard gauges to assess degree of under- or overestimation of rainfall (rain-splash out of funnels during times of high intensity or effect of a broad rim on drop partitioning, etc.). Make clear in what plots the measurements represented rainfall (e.g. UT4?) or throughfall? (NB: adjust subsequent language in main text accordingly whenever discussing 'rainfall' if needed, e.g. in section 3.1, etc.).

Add photos of position of gauges in Supplementary Materials since using only ïňĄve rain/throughfall gauges per plot would seem inadequate given the large variation in TF that is expected for such spatially variable vegetation? Also: two months duration, not three (lines 97-98) based on Figure 3.

Feedback comment 14 We revised as: "Rain gauges were installed in four observation locations (with adjacent erosion plots) upstream and four observation locations midstream of the Rejoso watershed. Each plot, the rainfall was measured with 5 replications. The rain gauges consisted of 30 cm diameter of funnel and bottle with a volume of 1.5 dm3 placed 120 cm above the soil surface and below the tree canopy with bamboo as a support. Rainfall was observed every day during two months of the rainy season, from March to May 2017".

We will add photos of position of gauges in supplementary materials.

We revised as two months duration.

Comment 15 *15, line 104: awkward description of the runoff measurement system. Suggest to use the term 'divider system' instead and give maximum collection capacity for the two drums plus divider system in litres of water. NB: the volume given in Figure 2 for the drums (30 cm3) must be erroneous. Also, was the metal plate guiding the runoff to the drums sheltered against direct rainfall inputs? If not, runoff amounts will have been over-estimated somewhat. *16, line 109: strictly speaking, volume has the dimension of litres or cm3, not mm of water. You could simply give the volume in litres and divide by plot area in m2 and remain all right dimensionally. Suggest to remove the hyphens in d-I etc. in Equations 1 and 3 as they can be read as minus signs rather than hyphens. NB: second Dd-I in Equation 3 should read Dd-II.

Feedback comment 15 We revised as: "In each plot, the water flow out through 13 holes of PVC pipes on drum-I was calibrated to be equal volume of water in each hole before runoff measurement.

Revision of Figure 2 is presented in supplement note 6.

In each plot, the water flow was collected into two collection drums with a capacity of 30 dm3. where the first drum has divider system with channeling into 13 channel PVC pipes with equally hole size and the levelling position and one of others connected with second drum. The volume of water come out from each hole we calibrate to get the water volume proportion enter into second drum. The potential capacity of the runoff

Printer-friendly version

Discussion paper

collector then can be = (25 dm3 * 13) + 25 dm3) = 350 dm3. Runoff samples at each plot were collected on every day at which rain occurred during the measurement period by measuring the water depth in each drum. The amount of runoff in each rain even was calculated using eq. (1) and eq. (2):

R_t= V_(d-I)+(13* V_(d-II)) [1]

V_d=1000* (D*L*W) [2]

Where Rt is total runoff (dm3); Vd is the water volume in drum I and II (dm3), L= Length and W width of drum (cm), D is the water depth in each drum (cm). The total runoff then converted as a mm unit by dividing areas of the plot (2 m x 6 m).

The soil erosion in each rain even was determined by collecting 1 dm3 of runoff-sediment in each drum. The sample was filtered with “newsprint” and dried in the oven with temperature 105oC to get the weight of sediment (S). The soil erosion in each rain even was calculated using eq. (3):

E=((V_(d-1)*S)+(13*(V_(d-2)*S)))*(ãĂŰ10ãĂŮˆ(-2)/A) [3]

Where E is soil erosion (ton ha-1); S is sediment (g dm-3), A is the areas of plot (m2).

The metal plate guiding the runoff to the drums sheltered against direct rainfall inputs.

Comment 16 *17, lines 111-112: what was the efïňĄciency of ïňĄltering your runoff samples using a newspaper compared to more conventional ïňĄlters (e.g. Whatman or Millipore 0.45 _m)? Rijsdijk and Bruijnzeel (1990a) used simple coffee ïňĄlters that were calibrated against conventional ïňĄltration. You may consider using a similar approach in future work. What about the sand fraction ending up in the ïňĄrst drum? Was the runoff water thoroughly stirred prior to taking the water sample? If so, inform the reader as such.

Feedback comment 16 We filtered the sediment sample using ‘newsprint’. The water through a filter ‘newsprint’ was relatively clear. Therefore, we consider that ‘newsprint’

Printer-friendly version

Discussion paper

filter is considered effective to trap the sediment. We did not calibrate between 'newsprint' filter with standard filter (e.g. Whatman or Millipore 0.45 _m) as part of this research, but will look for additional data from earlier studies in our lab The course sediment (sand fraction) was trapped in first drum. During the sediment sampling, the sediment and water in each drum was stirred vigorously before taking one liter of sediment samples.

Comment 17 *18, lines 122-125: did you take one block sample for bulk density measurement as suggested by the text or three? After all, you tested for differences in Table 2. How was particle density measured (by pycnometer?).

Feedback comment 17 We take one block sample (20 cm x 20 cm x 10 cm = 4000 cm3) for bulk density measurement. Particle density measured by pycnometer method.

Comment 18 *19, section2.5.1. Canopy cover: it only becomes apparent in line 134 that the vegetation plots measured 20 m x 20 m; suggest to indicate this at the start of the plot descriptions.

Lines 133-135: did you cover entire 5 m x 5 m areas with plastic/paper? References to Arumsari and Astutik are missing from reference list so cannot be checked (but might be in Bahasa Indonesia anyway and hence less accessible for most readers?).

Line 136: suggest to replace CV in Equation 5 by another symbol to avoid confusion with coefïňĄcient of variation. NB1: one could also derive the canopy cover fraction from measurements of throughfall for small storms that do not saturate the canopy. The slope of the regression line between incident rainfall and free throughfall equals the gap fraction (p), hence canopy cover fraction c equals 1 – p (Jackson, 1975). NB2: one wonders why direct observation of the contact cover fraction was not preferred to the more cumbersome (weighing/drying) litter mass approach? Contact cover fraction has been shown to be closely related to surface erosion rates in numerous cases (see e.g. Yu, 2005).

Feedback comment 18 We will revised that the vegetation plots measured 20 m x 20 m describe in the plot descriptions. The canopy cover can be defined as the percent tree canopy area occupied by the vertical projection of tree crowns (Jennings, 1999). The percentage of canopy cover is measured by scathing the shadow of sunshine at ground level using 10 m x 10 m of white paper. The canopy projection when the sun was overhead was drawn to scale on white paper in each of four quadrants of the 20 m x 20 m plots, after which the areas shaded were cut out and weighed separately. Canopy cover was calculated according to eq. (5):

%Canopy Cover=(W Canopy)/(W Total) X 100 [5]

Where: %Canopy cover is the percentage of tree canopy cover, W_Canopy is the paper weight representing canopy cover and W_Total the paper weight representing the total area of observation, respectively.

For the reference we will considered as discussion part.

Comment 19 *20, section 2.5.2. Understorey and litter: reference to Hairiah et al. is missing from the reference list (presumably the CIFOR publication). Indicate the number of replications used please. Using 50 cm x 50 cm would seem inadequate for understory measurements in the case of Lantana or Chromolaena shrubs. Were these present in the forest plots like they are in many plantations across Java?

Feedback comment 19 Understorey vegetation and litter were measured according to the rapid carbon stock appraisal protocol (Hairiah et al., 2011), using 50 cm x 50 cm samples for fresh weight, with subsamples dried for dry weight determination. (Note: this method is standard for Carbon Stock measurement)

The reference used: Hairiah K, Ekadinata A, Sari RR, Rahayu S. Measurement of Carbon Stock: from land level to landscape. Practical instructions. Second edition. Bogor, World Agroforestry Centre, ICRAF SEA Regional Office, University of Brawijaya (UB), Malang, Indonesia 110 p.[Indonesia]http://apps.worldagroforestry.org/sea/Publications/files/manual/MN0049-11.pdf. 2011

Comment 20 *21, section 2.5.3. Surface roughness: awkward formulation ('elevation', 'vertically'). Suggest rephrasing.

Feedback comment 20 Measurement of difference of elevation is set with a pixel size of 30 cm x 30 cm. Each plot is divided into 6 pixels for 2 m meters width and 20 pixels for 6 m plot length, so there are 120 pixels (N). Pixels are made on a flat plane as high as 30 cm from the ground point of reference with a thin rope. In each center the pixel is measured vertically parallel to the thin rope vertically towards the surface of the ground with a ruler. The results of measurements of height differences in each pixel are used to calculate Ra with the equation (HoechstNetter et al., 2008):

Ra= 1/N $\sum\_(n=1)$ⓇNh_n

Where N = Number of pixels in concerning patch; hn = difference of elevation between the n pixel in concerning patch and the mean value.

Comment 21 *22, line 187: daily rainfall totals do not represent rainfall 'intensity' although you might refer to 'event intensity' if event durations are known. Lines 188-190: this belongs to Discussion rather than Results and is rather speculative anyway given the non-linearity of the rainfall-erosion relationship. Add discussion on what might constitute 'tolerable soil loss' in the study area given the rate of chemical denudation of andesitic ashes (= approximate rate of soil formation; Verheijen et al., 2009). See e.g. Bruijnzeel (1983) who determined the rate of chemical weathering for a high rainfall area with Inceptisols in Central Java at ca. 85 t km-2 yr-1. Given the difference in rainfall between his site and the Rejoso catchment a value of ca. 40 t km-2 yr-1 might be defendable, suggesting the tolerable soil loss might be as low as 0.4 t ha-1 yr-1?

*23, lines 207-218 and 219-229: see main comments above.

Feedback comment 21 Erosion rates in all plots increased with amount of rainfall (Figure 5.a.3. and Figure 5.a.4). Midstream agroforestry systems had erosion rates range from 2.8 to 10.3 t ha-1 in the measurement period (Table 4). Move to discussion, inserted in line 230. As annual rainfall is approximately three times what was recorded in the measurement period, with similar rainfall intensities, these erosion rate are to be multiplied by a factor of 3, leading to 9 – 31 t ha-1 year-1. Even on volcanic soils, with frequent ash inputs, such erosion levels may be challenging sustainability.

Many authors have emphasized that the key to hydrologic functions is in the soil rather than the aboveground parts of the forest (Peña-Arancibia et al. 2019). Still, we found strong and direct relations with canopy cover. Positive effects of canopy cover on infiltration were related to raindrop interception in earlier studies (Carlesso et al. 2011; de Almeida et al. 2018). Interception will (a) reduce the destructive power of rainwater splash on the ground surface (as long as the effects Wiersum (1974) described are avoided, (b) allow more time for infiltration as water reaches the surface more slowly, (c) keep a thin water film on the leaves that will (d) cool the surrounding air when it subsequently evaporates. It will reduce the amount of water reaching the soil surface, but by increasing air humidity also decrease transpiration demand when stomata are open. In a study in North China, Li et al. (2014) showed that presence of litter of Quercus variabilis, representing broadleaf litter, and Pinus tabulaeformis, representing needle leaf litter, can reduce surface runoff rates by 29.5% and 31.3% respectively. The overall effect of fast plus slowly decomposing surface litter means protection of the soil surface from splash erosion, surface roughness that reduces sediment entrainment, an energy source for soil biota and a conducive microclimate (Hairiah et al. 2006, Derpsch et al., 2014)

Comment 22 *24, line 231: what was the original slope steepness in the mid-stream area before bench terracing? Line 232: awkward formulation. Line 233: remove reference to seawater intrusion since not pertinent to present case? Line 234: 'erodible', not 'erosive'. Line 240: Liu, not Zhipeng.

Feedback comment 22 Rev. line 231: From a land use policy perspective our results suggest that maintaining high (∼80%) canopy cover in the mid-slope farmer-controlled landscape under bench terracing that does not match the slope criteria for designation as watershed protection forest, is important.

In Indonesia, protection forest areas have the primary function as protection of life support systems to regulate water management, prevent flooding, control soil erosion, and maintain soil fertility (Government of Indonesia, 1999).

With the higher rainfall intensities here and more erodible soils, risks for degradation from a downstream It clearly matters what the land cover in the ‘non-forest’ parts of the landscape is and how vegetation interacts with soils and geomorphology in shaping rivers and groundwater flows (Liu et al. 2018; Zhao et al. 2019).

Comment 23 *25, line 245: in the middle and upper Rejoso watershed; Line 247: keep erosion at acceptable levels? Line 248: gentle slopes associated with bench terracing or inherently gentle? If so, one wonders about the need for bench terracing.

Feedback comment 23 Rev: Our results demonstrated that vegetation-based thresholds for adequacy of infiltration, given the existing rainfall intensities, differed in the middle and upper Rejoso watershed.

Rev: Despite steep slopes and low tree cover, the upper watershed with its course soil texture (pseudo-sand /silt), low bulk density due to high content of amorf mineral, strong micro-aggregation and individual mineral have sponge-pores typical of Andosols, land management practices that combine vegetable crops with a tree canopy cover of around 55% can maintain infiltration and keep erosion at acceptable levels.

Rev: In the midstream part of the catchment, despite gentle slopes under bench terracing, infiltration-friendly land use on the fine-textured Inceptisols required a canopy cover of 80%.

Comment 24 *26, lines 251-253: remove ‘was’ (four times); Remove Didik Suprayogo in lines 252-253.

Feedback comment 24 We revised as: “DS, W, KH and MvN designed the study. NM collected data in midstream, ALR collected data in upstream, RMI coordinated to collect the data in the field, academically supervised by DS, W and KH. DS, W, KH and MvN shaped the manuscript, which was approved by all co-authors”.

Comment 25 *27, references: standardize journal abbreviations, use of capitals, etc. Remove references not mentioned in text (Alvarenga, Anache, Boongaling, Choto, Kellner, Teklay); add missing references given in main text including Astutik et al. 2015; Hairiah et al. 2005, Hoechstetter et al. 2008, Suprayogo et al. 2017, etc.

Feedback comment 25 Corrected in revision text in supplement note 4

Comment 26 *28, diagrams: Figure 1, add latitude/longitude indications; Figure 2, move to Supporting Materials as it does not add much or replace by a Photo?; correct the volume of the collector drums; Figure 3, use less awkward dateindication; Figures 4, 5: indicate which panels refer to what land cover type; Figures 6-7: complete captions. Tables: add standard errors or coefïňĄcients of variation where appropriate.

Feedback comment 26 Regarding Tables we used Fisher’s LSD test ($p<0.05$). Figure 3 we revised in supplement note 7.

Please also note the supplement to this comment:
https://www.hydrol-earth-syst-sci-discuss.net/hess-2020-2/hess-2020-2-AC1-supplement.pdf

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2020-2, 2020.