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Discussions

Interactive comment on "The inbuilt long-term unfeasibility of environmental flows when disregarding riparian vegetation requirements" *by* R. Rivaes et al.

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The authors are very grateful for the comments of the referee. M. McClain presented especially relevant questions and points of view, although the authors respectfully disagree with some of those viewpoints. Responses to the general comments and numbered questions of the reviewer (stated as "Comment") are provided bellow (stated as "Response").

Comment: This study addresses the important topic of considering inter-annual flow requirements of riparian vegetation in the determination of environmental flow regimes in rivers. This is especially important in river reaches downstream of large dams capa-

ble of capturing and holding large flood pulses. In systems with less storage capacity, large floods are will propagate through the system at near natural levels, or even increased levels if upstream river sections include flood defenses. Thus the paper refers to a particular situation in the recommendation of environmental flow levels, but it is certainly a common situation. The authors suggest that current environmental flow science and practice devote too little attention to riparian vegetation and inter-annual flow levels, but this too is a particular situation that may be common in Europe where environmental flow methodologies are dominated by hydraulics-based analyses of habitat suitability. Other parts of the world, where more holistic methods like the Building Block Methodology, Savannah Method, and hydrologic indicator site method (e.g. Murray Darling Basin) are applied, devote substantial attention to riparian vegetation and its inter-annual needs. Moreover, hydrologic index approaches like the Range of Variability routinely consider and recommend floods of magnitudes that occur at recurrence intervals of 5 to 10 years or more. For these reasons I do not fully agree with the authors' assertion in the discussion (page 10715) that the capability demonstrated in their study "revolutionizes the actual paradigm in environmental flow science". I do, though, think it is an interesting effort to link instream and riparian processes and demonstrate the feedbacks between them.

Response: The authors agree that this paper refers to a particular situation in the recommendation of environmental flow levels as flooding regimes are affected differently according to the impoundment structure and the reservoir management. Actually, the authors have also noticed this circumstance before, regarding riparian flood flow requirements (Rivaes et al., 2015). Naturally, the ecological succession of riparian vegetation is a dynamic equilibrium based on the dynamic disturbance of the flow regime. As a result, a healthy riparian community depends on flood disturbance of different magnitudes, where small and more frequent floods are as important as large and infrequent ones to ensure the continuity of the metastable, oscillation and acyclic processes that govern riparian ecological succession (Formann et al., 2013). Furthermore, one may not neglect that all dams, weirs and levees change to a certain extent the magnitude of peak flood flows of rivers, and that environmental flow restoration is still able to be implemented at hundreds of thousands of these structures around the globe (Richter and Thomas, 2007). This condition encompasses different river types, storage capacities or reservoir uses, being common all over the world, not only in Europe (Nilsson and Berggren, 2000). For instance, flood flow modification encompasses the entire United States with a substantial extent (FitzHugh and Vogel, 2010). In Australia, only floods with recurrence intervals of 20 years or higher didn't change appreciably with regulation (Maheshwari et al., 1995), which in fact may even promote vegetation encroachment (Miller et al., 2013). The modifications in African and South American floodplains downstream of impoundments are also evident (Uddin et al., 2014a, b). For these reasons, although the considered environmental flow recommendation may be particular, the effects of flow regulation and flooding regime change seem to be more than just a particular case and be of interest to water managers and researchers around the globe. The issue of environmental flow science still devoting too little attention to riparian vegetation has been recently acknowledged by several authors (e.g. Acreman et al., 2009; Acreman and Dunbar, 2004; Annear et al., 2002; Arthington, 2012; Arthington et al., 2003; Gillespie et al., 2014; Tharme, 2003), as well as the need for more research devoted to the evidence for ecological relationships between flow regime and riparian vegetation (Miller et al., 2013) and a better understanding of the effects of flow on ecosystem function and species interactions (Acreman et al., 2014). The authors agree that environmental flow determination based on holistic methodologies is undeniably increasingly being tried out of Australia and South Africa (Hirji and Davis, 2009) but the most commonly applied methods throughout the world are still hydrologically-based methods (Allan and Castillo, 2007; Dyson et al., 2003; Linnansaari et al., 2012; McKay, 2013; Tharme, 2003). The holistic methodologies try to incorporate the water requirements of the entire riverine ecosystem by approximation to the natural flow regime and therefore maintain all the existing species. However, such approaches include methods that are in most cases relatively general and lack any specific detail on ecological response or river hydraulics and geomorphology (Acre-

man and Dunbar, 2004). Also, when flood flows are recommended by hydrologic index approaches, the outcome of those flows on vegetation are hardly ever predicted, even less during an adequate time period in order to provide support for decision making. On the other hand, habitat modeling can be used to identify relationships between biota and physical habitat, as well as to assess its quality and to predict probable biological responses facing hydromorphological changes (Conallin et al., 2010). These habitat modeling techniques have been considered as the most scientifically defensible methods to appraise physical habitat (Dunbar et al., 1998; Gore and Nestler, 1988; Tharme, 2003) among other several advantages (Acreman and Dunbar, 2004; Arthington, 2015; Davis and Hirji, 2003). Furthermore, the empirical knowledge points out the greatest probability of water managers and stakeholders in accepting environmental flow recommendations based in strong evidence of the processes connecting flow and ecology (Arthington, 2015). Evidently, there is no single best method, approach or framework to determine an environmental flow (Dyson et al., 2003) but habitat modeling methods still provide in general the higher relative confidence in results (Davis and Hirji, 2003) and are suitable for impact assessment at specific sites (Acreman and Dunbar, 2004). Thus, these methods provide simple indices of habitat availability that offer decision makers a vision of the expected response of biological communities regarding the considered flow regime change scenarios on an appropriate time. Moreover, these methods can be carried out as a part of an holistic approach (Acreman and Dunbar, 2004) and provide a supplementary way of assessing ecological response, thus contributing to the reduction of the uncertainty regarding the ecosystem response to flow regime, since the relationships between flow change and riparian ecology are very specific and often inconsistent (Poff and Zimmerman, 2010). The intention of this study is to assess the physically-based effects of riparian habitat degradation on the aquatic habitat and to evaluate the importance of considering riparian vegetation requirements into environmental flows. Consequently, the paradigm revolution mentioned in this paper is attributed to two main issues: i) a shift from expert advice towards more quantitative and predictive methods regarding riparian vegetation, based on process-based modeling, hence providing higher confidence information regarding riparian vegetation requirements, and ii) to provide evidence that an environmental flow regime considering only fish requirements become obsolete in few years and that considering riparian vegetation requirements is an important aspect to consider into the determination of long-term effective environmental flows.

Comment: That said, I have the following questions and remarks, which address aspects of the manuscript and analysis that I believe require clarity or more attention. 1. What are the discharge data used in the study? Where is the gauging station relative to the study site? What is the length of record, time step, and degree of completeness? I refer to the data used in the production of the monthly flow levels shown in Figure 1 and the source of the annual high flows used in the riparian vegetation modeling.

Response: The description on how the considered environmental flow regime was determined was not thoroughly described because the authors found it to be out of the scope of this study. This was an existing proposal considering riparian requirements that the authors accounted as a case study. Notwithstanding, the discharge data used in the study are mean daily and maximum instantaneous discharges, recorded in a gauging station located approximately 2.7 km downstream of the study site. Despite the small distance from the gauging station to the study site, the discharges at the study site were computed taking into account the area and the mean annual precipitation ratios between the drainage basins of the gauging station and of the study site. The available length of record goes back to 1984 with continuous daily data.

Comment: 2. How is the riparian vegetation model calibrated? The authors refer to other papers for the explanation of calibration. I checked one and did not find a sufficient explanation there either. Does the calibration/validation include, as one would expect, comparison of the model outputs with measured data from other years and time periods? If so what are these data? Are they aerial photos from previous years or something equivalent? More details are needed here to demonstrate the model's performance.

Response: Model calibration was achieved by comparison between expected and observed vegetation maps at the same year, i.e., comparison of the model output with measured data in the field. Age and height above water table parameters were defined from vegetation and habitat surveys of the study site and were therefore calibrated by the establishment of thresholds based on in situ fieldwork. The parameters for vegetation shear stress resistance thresholds were tuned by an iterative process of trial and error that sought to attain the best calibration outcome. The expected vegetation map was obtained by modeling approximately a decade of the natural historic flow regime ending at the same year of which the vegetation was surveyed. The 10-year periods were used to avoid the effect of the initial vegetation conditions on the results, which influence only the first five years of simulation, while longer simulation periods were not considered due to the relevance that river morphological changes may assume in vegetation development. Observed and expected vegetation maps were compared on a cell by cell basis, and the resultant confusion matrix was analyzed with Cohen's Kappa. This information is patent in the provided references. The riparian vegetation model was also validated by running the calibrated model in a different study site located further downstream. By these means, a spatial validation was achieved by assessing model accuracy with independent data from a different study site near the previous one. Once again, model accuracy was assessed by comparing expected and observed vegetation maps, which in this case retrieved even better accuracy results than calibration. The validation procedure is also explained in the provided references, with the exception of those examples refer to a temporal validation instead of spatial validation.

Comment: 3. More explanation is also needed about the model output shown in Figure 3. Arethese maps of vegetation on a particular year of the simulation or some sort of longterm mean configuration? The paper refers to vegetation being modeled in a 10-year period, but what does that mean exactly. I noted in the environmental flow regime in Figure 2 that there is a large flood in year 9. Are the figures for year 10 immediately after that big flood? The fact that the Eflow panel in Figure 2 shows most of the area in the early succession woodland phase suggests that only 10 years has passed. Given that scenario includes no floods I assume the entire flood plain will eventually move into the forest phases.

Response: The maps presented in Figure 3 are the ones expected after a decade of simulating the considered flow regimes. Namely, the results show the riparian patch mosaic that is predictable to exist in ten years according to each flow regime. The CASiMiR-vegetation model simulates the influence of physical river processes on the survival and recruitment of riparian vegetation, and its output is a year-based temporal and spatial representation of the expected riparian succession phases. Thus, for each year, the model replicates the succession/retrogression of riparian succession phases determined by the shaping action of shear stress and flood duration in the wet season, and the hydric stress in the dry season, according to the inputted flow regime. The work flow of the model is this: starting from an initial vegetation map provided by the user or by the model, the model exerts on each succession phase the mentioned stresses determined for the first year of the inputted flow regime. The diverse succession phases have different resistance thresholds for those stresses and where any of those are exceeded implies the retrogression of the corresponding succession phase. Where the mentioned stresses are lower than that resistance thresholds, then vegetation succeeds and age another year. When a succession phase reaches its age limit, it passes to the next succession phase. Therefore, the model applies sequentially the mentioned stresses on riparian vegetation and the resulting vegetation map stands for the succession phases of vegetation which resisted to those stresses, and the areas of initial succession phase resulting from the retrogression of the succession phases where resistance thresholds were exceeded. This resulting vegetation map is then used as initial vegetation map of the second year run. Once again, in that year run, the model exerts the corresponding stresses of that hydrologic year on vegetation and so on. Saying that the vegetation is modeled for a 10-year period means that this influence of the physical river processes on riparian vegetation is performed 10 times (one each hydrologic year) in a dynamic way in which the initial map of each model

run is the riparian vegetation map resulting from the previous modeling run. Figure 2 shows the environmental flow regime considering both aquatic and riparian requirements. The environmental flow regime regarding only fish requirements, acknowledged as Eflow regime, only considers the monthly discharge that is addressed to fish requirements. The environmental flow regime addressing both fish and riparian requirements, the Eflow+flush regime, considers both the monthly and the flushing flow discharges shown in the graphic. This flushing flow regime presents a flood of 10-year recurrence interval in the 10th year. Table 1 provides a description of the flood discharges that characterize the three considered flow regimes. According to Table 1, one can see that a flood with such recurrence interval is not expected for the Eflow regime. The expected riparian vegetation map subjected to the Eflow regime (no floods) reveals that after ten years the majority of the vegetation that was in the initial succession phase (IP), is able to succeed and develop inside channel to early succession woodland phase, which corresponds to vegetation with an age range between 6 and 19 years. This means that where naturally exists only bare soil or recruitment up to 2 years, after 10 years of Eflow, those areas are covered by vegetation with ages between 6 to 19 years old. If longer periods occur without flood disturbance, these patches will certainly continue to succeed to older forest phases. In the outer parts of the river, vegetation has also succeeded but it takes more than 10 years to move on to the next succession phase and, therefore no differences are noticed in such modeling period.

Comment: 4. I was surprised that the influence of riparian vegetation on fish habitat was only considered in its influence on channel roughness. Riparian vegetation serves so many other important functions, including cover, substrate and shelter for eggs and fry/juveniles, food sources, etc. Why only roughness, and why was 'cover' not included in the habitat suitability index (equation 1) as it usually is?

Response: The authors agree that riparian vegetation serves many other important functions as commented but the scope of this work was to study the influence of riparian vegetation degradation on river channel hydraulic parameters and consequently on fish habitat availability. For this, depth, velocity and substrate have been considered the most important variables determining fish diversity and distribution (Gorman and Karr, 1978). Notwithstanding, during the fish requirement assessment stage, the authors assessed habitat use and availability for water depth, flow velocity, substrate and cover. The riparian vegetation modeling is however a subsequent stage in which the CASiMiR-vegetation model only reproduces the riparian area. The part of the river channel that is permanently submerged, denominated in the riparian model as aquatic zone, is not considered in the modeling because riparian woody species are unable to establish in such conditions. Although one may have macrophyte species in this area, this will always be an initial phase regarding riparian vegetation, unless it becomes temporarily emersed for any reason. Furthermore, from the vegetation survey, succession phases may even be characterized by particular indicator species, but the model is not able to reproduce the species richness of the riparian vegetation, neither to define the exact location of each species individuals. Accordingly, substrate cover cannot be correctly modeled by the riparian vegetation model, particularly in the aquatic zone. Therefore, inferencing vegetation cover from the resulting succession phases seemed mere speculation to the authors. One can argue about hanging vegetation, but once again, from this model this is not possible to determine accurately and therefore was not considered a reliable variable to take into account in the hydrodynamic modeling. Moreover, this hanging vegetation was not representative of the natural study site, and therefore, preferences for this specific cover were not made available. In addition, no significant difference was detected in riverbed substrate between succession phases either, maybe because the typical boulder substrate is too coarse for this. Anyway, changing the substrate according to the succession phase disposal seemed also to the authors to be an incorrect practice. For these reasons, the riverbed characteristics of substrate and cover were kept unchanged in the ensuing hydrodynamic modeling and therefore made no sense to perform a comparison analysis between riparian scenarios regarding those two variables.

Comment: 5. Related to the point above, I found the effects of roughness on depth

and velocity (page 10714 lines 1-6) to be incredibly small. While the differences may be statistically significant given the consistency of output data, the real significance is questionable. Depth varied by no more than 3-5 mm and velocity varied by no more than 0.007- 0.008 m/s between the simulations. What evidence would support that these small differences have a significant impact on ecological status and function?

Response: Results regarding water depth and flow velocity are based on 671961 points, calculated throughout the study site area submerged by the Eflow discharges. This circumstance characterizes very approximate mean values which, nonetheless, are significantly different according to the employed statistical methods with a 95% confidence level. Moreover, despite the small divergence between these values, one must take into account that these refer to a mean value for the entire study site, characterizing the central tendency of the entire distribution. However, when comparing water depths and flow velocities point by point, one can find differences between scenarios up to 10 cm in water depth and more than 40 cm/s in flow velocity. In fact, the hydrodynamic modeling results reveal that the water flow near the margins is more affected than the water flowing in deeper areas of the river channel. One reason for these results may be because this study is about the effects of riparian vegetation encroachment on the physical habitat due to the colonization of the river margins by woody riparian vegetation. Accordingly, there are locations where the considered hydraulic parameters change considerably, shifting the habitat preference of fishes in one or two classes of the corresponding habitat preference curves. These changes are particularly important considering that a shift of one class regarding these parameters is sufficient to change fish preferences from near null to maximum and vice-versa in many cases, as it can be seen in the preference curves provided in the supplementary material. Furthermore, analyzing the hydraulic parameters per se does not give a proper vision of the habitat changes. The habitat suitability is the result of the multiplication of suitability indexes and, consequently the differences in those hydraulic parameter preferences can in fact create substantial variations in the habitat suitability, as it can be observed in Figure 5. In this case study, differences in water depth and flow velocity changed habitat availability up to 80% depending on species, life stages and seasons. Such changes in habitat availability can have significant impact on ecological status and function of the extant fish communities, as there is a close relationship between habitat and fish production (Freeman et al., 2001; Hunt, 1974; Jones et al., 1996; Jowett et al., 2005; Randall and Minns, 2000; Sharma and Hilborn, 2001) which is one of the most significant surrogates for population success (Hunt, 1974; Mann, 1971). Effectively, habitat loss is the major threat concerning fish population dynamics and biodiversity (Bunn and Arthington, 2002) promoting population changes with a proportional response to the enforced habitat change (Cowley, 2008).

Comment: 6. Again related to point #4, how was the effect of roughness exactly considered in the habitat modeling? Most of the riparian vegetation is clearly outside the wetted channel and would rarely (if ever in Eflows scenario) be wetted. Was only vegetation positioned in the wetted channel considered to affect flow?

Response: The diverse riparian habitats were represented in the hydrodynamic model by changing the channel roughness accordingly to the spatial extent of the expected riparian succession phases. Roughness classification of riparian vegetation succession phases was determined based on roughness measurement literature of similar vegetation types (Chow, 1959; Wu and Mao, 2007). Where vegetation is not expected to exist, channel roughness was determined according to the existing channel substrate. Figure 3 shows the riparian habitat scenarios resulting from the riparian vegetation modeling. Here, the blue color named as “water” stands for the aquatic zone, which is submerged during the entire hydrological year and, therefore is not modeled by the riparian vegetation model. As a result, this blue area stands for the minimum discharge of the hydrological year. The different discharges determined for both environmental flow regimes create greater inundation areas than the perceptible aquatic zone and are not presented in any of the vegetation maps. Furthermore, because the aquatic zone is not modeled by the riparian vegetation model, its hydraulic characteristics are kept unchanged throughout the considered scenarios and thus all the changes in wa-

ter depth and flow velocity must be due to the interaction of the water flowing through the different succession phase patches which are inundated by the environmental flow discharges. The vegetation maps were transposed to the hydrodynamic model for all the extension of the study site. Therefore, all the vegetation patches were considered to affect flow. Practically, the vegetation patches affecting river flow were all the ones that, due to the river stage of the considered environmental flow discharges interacted with the river flow.

Comment: 7. Given these questions I do not believe that assertions in the discussion, such as “The habitat decrease of barbel and nase juvenile during autumn and winter months jeopardizes those species survival” are convincingly supported by the modeling results. The criteria for habitat suitability appear very sensitive while the real uncertainty in the influence of the changes is large in my estimation. The results are of course also distributed such that ‘more’, as well as ‘less’ habitat is created by altered flow regimes. The authors argue that any change from their simulated ideal is negative, and this too is subject to considerable uncertainty.

Response: The authors do not agree with M. McClain on this point. The authors are confident that the discussion and conclusion chapter are supported by the results and that the adopted methodology can sustain a suitable response to the authors research questions. Several points are stated to rebut M. McClain’s arguments, particularly in the context of the authors research questions.

Research question: are the fish only-addressed environmental flows capable of preserving the habitat availability of aquatic species in the long-term?

i – The authors selected an environmental flow regime regarding only fish requirements. This environmental flow was established using the Instream Flow Incremental Methodology, the worldwide most used habitat modeling method (Tharme, 2003).

ii – The assessment of the habitat availability was performed using state of the art modeling techniques specifically calibrated for the considered study site. The hydrodynamic modeling was performed with River2D model, a widely used software in instream habitat modeling (e.g. Boavida et al., 2013; Katopodis, 2014) for which the fish habitat predictive ability was already properly validated (e.g. Boavida et al., 2013; Gard, 2009). The long-term changes of the riparian habitat were modeled using the CASiMiR-vegetation model, a novel process-based tool capable of reproducing the effects of the flow regime disturbance on riparian vegetation in a dynamic and spatially distributed fashion. This software was already applied in different rivers around the world with fairly good results regarding model accuracy (e.g. Benjankar et al., 2010; Egger et al., 2009; Egger et al., 2013; Egger et al., 2012; García-Arias et al., 2013; Politti et al., 2014).

iii – The riparian habitat was modeled according to the natural flow regime and the fish only-addressed environmental flow regime (Eflow), in order to determine the accumulated effects of each flow regime on riparian vegetation during a period of a decade. As one can notice in Figure 5, natural and Eflow expected vegetation maps are clearly distinctive.

iv – The obtained expected vegetation maps were inputted into the hydrodynamic model by changing channel roughness accordingly to the spatial extent of each succession phase patch. The roughness estimation of the vegetation succession phases were based on literature.

v – Results from the hydrodynamic modeling show differences in water depth and flow velocity estimations between natural and Eflow riparian habitats. Differences in many places can reach up to 10 cm and 40 cm/s, regarding water depth and flow velocity. These differences proved to be significantly different with a 95% confidence level.

vi – The resulting differences in the hydraulic parameters generate altered habitat availabilities throughout the year according to season, species and life stages, which can depart to the utmost of 80% from the natural habitat availability. On average, those changes are greater than 10% and are more severe in species with greater habitat

requirement specificity and less natural available habitat (see Table 2). These changes also proved significantly different in more than a quarter of the cases between natural and Eflow habitats with a 95% confidence level.

vii – Habitat deviation from the natural reference was interpreted by the authors as a deviation from the reference condition and therefore a degradation of the habitat availability which contributes to the degradation of the ecological quality of the considered fish communities. Habitat availability is closely related to fish population dynamics and success. This is a common scientific community acknowledgement, attested by the provided references in the former sections of this response.

viii – In sum, after a decade of flow regulation by the Eflow (fish only-addressed environmental flow), the riparian habitat becomes significantly different, changing significantly the hydraulic parameters of the river channel, which in turn modify significantly the habitat availability of the river stretch and consequently leading to modified fish populations.

Research question: In what extent could this overlook derail the goals of environmental flows addressing only aquatic species as a result of the riparian habitat degradation?

ix – The Eflow regime was determined based on habitat availability curves underpinned by the natural habitat. This environmental flow regime is projected to provide the necessary habitat for fish population sustainability. After a decade of regulation with such environmental flow regime, the riparian habitat has degraded, creating a circumstance in which the existing habitat does not support anymore the considered habitat availability curves. Therefore, after a decade of regulation using this environmental flow regime, the prescribed monthly discharges do not provide any longer the intended habitat amounts.

Research question: Are environmental flows regarding riparian requirements able to maintain the habitat availability of fish species?

x – The authors selected an environmental flow regime regarding both fish and riparian vegetation requirements (Eflow+flush) in which the prescribed flood discharges were determined by process-based modeling, thus providing an insight of the expected riparian vegetation response to the selected regime. The authors decided to test an environmental flow regime regarding riparian requirements in which the response of riparian vegetation was already predicted to ensure that the considered flow regime was in fact expected to be able to maintain riparian vegetation near natural circumstances. Other methods that claim to address riparian requirements could have been selected but they are hardly ever tested previous to its implementation and therefore may or may not be effective in their proposal (see Rivaes et al., 2015 for a better understanding).

xi – As anticipated, riparian vegetation modeling results demonstrate that the considered Eflow+flush regime was able to maintain the riparian habitat near natural standards and, therefore after a decade of flow regulation with such flow regime, water depth and flow velocity estimations were not significantly different from the natural riparian habitat, with a 95% confidence level.

xii – Habitat availability was also never significantly different from the natural habitat availability with a 95% confidence level.

xiii – According to these last topics, the authors are led to assume that after a decade of flow regulation by the Eflow+flush regime, the possible riparian habitat changes do not significantly change the river hydraulic parameters and consequently the habitat availability of the river. Thus, this circumstance still supports the considered habitat availability curves for the prescription of the monthly discharges and therefore, after a decade of regulation using this flow regime, the prescribed monthly discharges still provide approximately the same intended habitat amounts as in the beginning of flow regulation.

xiv – The authors tried to keep uncertainty as low as possible, although uncertainty from ecological modeling is always present. Nevertheless, the authors have investi-

gated this issue before and detected that fulfill some minimum requirements during topographic survey and model calibration, the uncertainty due to modeling remains fairly low (Boavida et al., 2013; Rivaes et al., 2013).

xv – To analyze the effects of the considered environmental flow regimes, the authors carried out an assessment based on the divergences from the ecological succession reference estate determined by the natural flow regime. This reference stands for the maximum condition of the riparian vegetation ecological succession which is determined by the unregulated natural hydrological regime, hence representing the highest ecological state, the benchmark of the study site. Both riparian scenarios resulting from the environmental flow regimes were compared with this reference and the detour of each one to the reference was assessed. Results revealed that the Eflow scenario created an ecological state farther apart from the reference than the Eflow+flush regime scenario. Indeed, the authors considered that a higher detour from reference implies a lower ecological status, as considered by the generality of the biological monitoring methods (Ziglio et al., 2006). Moreover, the model uncertainty of this reference was assessed by comparison with observed data and revealed a good agreement.

In the end, the authors argue that environmental flows disregarding riparian requirements are sentenced in the long-term, as one considers demonstrated in the previous topics. The authors agree that these can be particular cases of environmental flows regimes, but it is consensual that every riparian and fish community is affected by flow regulation with a consequent ecological degradation proportional to the regulation magnitude. Eventually, every environmental flow regime disregarding those requirements will sentence those communities to degradation.

Comment: 8. Finally, how was the considered environmental flow regime “adapted” (page 107009 line 18) from the environmental flow regime proposal for the future Alvito dam? What did the adaptation consist of? Why no citation of the work for Alvito dam?

Response: There is an environmental flow regime proposal for the future Alvito dam.

This environmental flow regime is considered to address aquatic and riparian requirements. This environmental flow regime considers two components of the flow regime, monthly discharges to meet fish requirements and maximum annual discharges of different recurrence intervals to meet the riparian requirements. The adaptation consisted in creating two different environmental flow regimes out of this one. The environmental flow regime addressing both fish and riparian requirements (Eflow+flush) was the proposed environmental flow regime for the future Alvito dam, without modifications. The environmental flow regime addressing only fish requirements (Eflow) considered just the monthly discharge component of the proposed environmental flow regime. This information comes from the project technical report which can be cited as Ferreira et al., 2014.

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