Responses to reviewer 1 comments

We thank the reviewer for their detailed comments, considered questions and positive suggestions to improve the manuscript. We have included comprehensive point-by-point responses to all comments below.

<u>Specific comments</u>

P. 2710 Line 20: the inference that alluvium is poorly-drained is too general – sandy alluvium can be very well drained.
Response: Added clarification to sentence. *Conversely, poorly-drained soils, such as Gleys (surface and groundwater) and silt and clay dominated alluvial soils in proximity to watercourses, are at greater risk of overland-flow generation and surface soil erosion due to reduced infiltration capacity.*

P. 2712-2713: in the description of the study locations the authors do not refer to the Quaternary sub-soils in the catchments. Could the authors comment on the role of Quaternary sediments in terms of soil development, catchment hydrology and erodibility.
Response: The combined effects of geology and the development of quaternary deposits dictate the contemporary heterogeneity of soil types and hydrological pathways associated with these. We have added a brief summary of Quaternary sub-soils for each catchment in the study location section.

Grassland A: A coarse loamy drift with siliceous stone subsoil is underlain by Devonian old red sandstones and mudstones from the Toe Head and Castlehaven formations (Sleeman and Pracht, 1995), which form an unconfined productive aquifer (Mellander et al., 2014).

Grassland B: Soil type is predominantly poorly-drained Groundwater Gleys in the catchment lowlands with a clay loam texture in A- and B-horizons resulting from a clayey calcareous Irish Sea till subsoil. The uplands contain smaller areas of well-drained Brown Earths, these soils are underlain by drift deposits with siliceous stones.

Grassland C: Soils are mainly deep and moderate- to poorly-drained characterised by a loam A-horizon texture and clay loam B-horizon, and areas of shallow well-drained soils in the upper catchment areas underlain predominately by Lower Palaeozoic shale tills.

Arable A: Subsoils predominantly comprise fine loamy drift with siliceous stones over slate and silt stones of the Oaklands Formation (Tietzsch-Tyler et al., 1994), which produces a poorly-productive aquifer.

Arable B: Subsoil is dominated by fine till containing siliceous stones with fluvioglacial sediments located near-channel.

P. 2718 para 2: did the authors assess how effectively the suspended sediments were mixed in the ex-situ tank and was there any settling of sediment that could account for the lower SSCs recorded by the ISCOout set-up?
Response: No particulate deposition was evident therefore the tank was assumed to be well-mixed. A sentence has been added to reflect this clarification: *The instrument tank was assumed well-mixed as no particulate deposition occurred.*

P. 2720: the authors refer to low runoff length - can this be quantified? Was there any evidence of the sediment trapping at hedgerows and in the vegetated ditches that the authors refer to?
Response: The actual runoff length was not quantified in this instance. Rather, we were referring to the impact of small fields, hedgerows and ditches on reducing the 'potential' runoff length, i.e. water and sediment connectivity and the reduced erosion potential of hillslopes with decreased slope-length compared to landscapes with larger fields (Lal, 1988). We considered a proxy metric 'maximum downslope length' to approximate 'potential runoff length' we have added this metric and others to Table 1 for all catchments. There was evidence of interception of sediment pathways and prevention of soil loss by hedgerows moreso in the arable compared to the grassland catchment. The sediment storage capabilities of drainage ditches in two of the monitoring catchments was summarised by Shore et al. (2014), a citation to this publication has been added to the text. Further clarification of these points was added to the text: *Catchment observations suggest high landscape complexity, comprising small and irregularly shaped fields, separated by a dense network of hedgerows and vegetated ditches (Table 1) reduced water and sediment connectivity potential between hillslopes and the channel network. Efficient drainage can be considered to reduce the spatial extent and temporal stability of*

connected areas and, considering the over-engineered nature of these ditch networks, encouraged sediment deposition (Shore et al., 2014). Furthermore, lower slope-lengths reduce the hillslope erosion potential (Lal, 1988), and sediment trapping and soil erosion prevention by root binding of hedgerows was observed.

P. 2722-2723: could the authors comment on the importance of scale in this study and the general attributes of the study catchments as representative of the Irish landscape. The inference that low SDRs are indicative of the Irish landscape's resilience to erosion is misleading, because SDR is a function of connectivity rather than the degree of field-scale soil erosion.

Response: Comments regarding the scale of study and representativeness of catchments to the Irish agricultural landscape have been added. The reference to the sediment delivery ratio has been removed such that it maintains clarity with the next sentence in the text. Passage now reads: *Overall, annual average sediment metrics from small catchments (~10 km^2) with dominant land uses representative of main land use types in Ireland reported here are internationally low. Considering the spatial dominance and intensity of agricultural land use and high effective rainfall in the study catchments, this is perhaps unexpected particularly considering the small scale of study. As previously discussed the complexity of landscape features (e.g., fields, hedgerows, ditches) which are representative of the wider Irish agricultural landscape (Deverell et al., 2009) can be expected to decrease the likelihood of field-scale soil erosion, and/or increase the opportunity for interception and deposition of mobile particles on land or within the hydrological network. The Irish landscape may, therefore, improve the resilience of agricultural soils to soil loss.*

P. 2723: to follow on from the comment above, the authors infer that the Irish landscape may 'improve the resilience of agricultural soils to soil loss'. This statement appears to be predicated on the low SSYs from the study catchments compared to the larger regional dataset shown in Fig. 4. Could the authors comment on the catchment characteristics from this larger dateset and whether the small catchments, in particular, represent comparable low-lying catchments and soil types. In other words, how are these catchments 'equivalent' as stated on p.2724, line 9? For example, the 26 small cultivated catchments in the Verstraeten and Poesen (2001) study were located in Belgium on the European loess belt which has highly erodible soils.

Response: The reviewer is correct that these catchments are not 'equivalent'. This word has been replaced with 'similar' as the catchments have common climate characteristics and some have similar catchment size. Other characteristics such as soil type are not necessarily equivalent. *Average annual SSYs in all five Irish catchments reported here were low in comparison to similar catchment and landscape settings elsewhere in Europe*.

P. 2724 Lines 1-3: the authors conclude that there was little difference between the in-situ and ex-situ set-ups, in terms of the total sediment loads and patterns observed. Could we conclude from this finding that there is no need to go to the trouble of employing an ex-situ installation approach? Furthermore, could the authors clarify what additional infrastructure (e.g. power supply) was needed for the ex-situ method and give some indication of the comparative costs involved for the two approaches. This information would be useful for researchers looking to replicate the methodologies employed in this study.

Response: The power supply and installation/maintenance/consumable needs and cost details are reported by Melland et al. (2012b), and this reference has now been added to the text. The overarching objectives of the Agricultural Catchments Programme was to monitor the efficacy of land management policies, and the expense of the ex situ approach was justified in order to capture high temporal resolution and continuous measurement of multiple water quality parameters. For turbidity-based SSC assessment alone, the resolution of data collection was identical at in situ and ex situ locations and whilst the quality of information from the data was similar between approaches, added benefits of an ex-situ approach would be greater security of probes, easier maintenance, and consistent power supply. However, both approaches suffer from limitations, with, for example, blocking of the pump serving the ex situ instrumentation tank and sensor saturation/spurious reading at the in situ turbidimeter. The impact of these limitations are now more clearly presented in Fig B. Missing data accounted for similar proportions of the ex-situ and in-situ SSLs (added text to P2717 paragraph 1). Researchers will be able to use the information presented in this study to help decide if the ex situ approach is appropriate for their specific research objectives.

Additions to the manuscript to reflect the points above are:

P2719 L10: *The suitability of ex situ water monitoring equipment installation must consider programme specific research objectives. Melland et al. (2012b) stated that for policy evaluation studies including multiple water quality parameters in addition to SSC, the improved resolution, accuracy and precision, in particular for hydrologically dynamic catchments, justified the increased financial costs of initial installation of ex situ instrumentation.*

P2714 L7: *All catchments had identical instrumentation deployed for temporally high-resolution nutrient, conductivity, temperature and turbidity data capture using bankside analysers mains powered at 230V (Wall et al., 2011; Jordan et al., 2012; Melland et al., 2012b).*

P. 2724 line 19: the statement 'complexity of the landscape' is a little vague and needs some explanation in the Conclusion.
Response: clarification added. *Complexity of landscape features (hedgerows, drainage ditches and irregular field sizes) may provide resilience to soil erosion and/or sediment transport despite spatial dominance and intensity of agriculture and these will be important considerations for future management (such as sustainable intensification) and/or SS mitigation in Ireland and elsewhere.*

<u>Technical comments</u>

Abstract
P. 2708 Line 11: Change sentence structure to remove semi-colon and clauses.
Suggested new sentence:
The in-situ and ex-situ installations gave comparable results when calibrated against storm-period, depth-integrated SS data, with total loads at Grassland B estimated at 12828 t and 15435 t, and 22554 t and 24852 t at Arable B, respectively.
Response: Accept. *The in-situ and ex-situ installations gave comparable results when calibrated against storm-period, depth-integrated SS data, with total loads at Grassland B estimated at 12828 t and 15435 t, and 22554 t and 24852 t at Arable B, respectively.*

P. 2708 Line 19: Replace (FFD) with (78/659/EEC).
Response: Accept. *Average annual suspended sediment concentration (SSC) was below the Freshwater Fish Directive (78/659/EEC) guideline of 25 mg L^{-1}, and the continuous hourly record demonstrated that exceedance occurred less than 12% of the observation year.*

Introduction
The introduction is well-written, but is quite long and narrows to a consideration of the installation set-up rather than the controls on SSC. Suggest shortening overall, and aligning the structure of the Introduction to match the paper title and abstract.
Response: Considering the comments of reviewer two we have an increased the emphasis on the technical method comparison data.

P. 2709 Lines 19-26: this is a long sentence and does not require semi-colons. The terms 'greater' and 'better' suggest a comparison to some condition/state which does not appear to be the case.
Suggested new sentence:
A comprehensive evaluation of the extent of erosion and elevated sediment supply, therefore, requires a robust determination of sediment flux (Navratil et al., 2011), knowledge of the sources and fate of fine sediments within the system (Walling, 2005), and an appreciation of the risks that elevated concentrations present to aquatic ecosystems (Bilotta and Brazier, 2008).
Response: Sentence replaced. *A comprehensive evaluation of the extent of erosion and elevated sediment supply, therefore, requires a robust determination of sediment flux (Navratil et al., 2011), knowledge of the sources and fate of fine sediments within the system (Walling, 2005), and an appreciation of the risks that elevated concentrations present to aquatic ecosystems (Bilotta and Brazier, 2008).*

P. 2709 Line 26: Change to 'integrated land, water and sediment…..
Response: Added word 'integrated' into sentence. *This evidence base can be used to better inform integrated land, water and sediment management strategies.*

P. 2710 Line 5: add a comma after 'preparation'.
Response: Comma added. *Arable farming typically involves the mechanical redistribution of soil through ploughing and seed bed preparation, and via erosion from compacted and/or bare fields and down-slope tramlines (Chambers and Garwood, 2000; Withers et al., 2006; Boardman et al., 2009; Silgram et al., 2010; Regan et al., 2012; Soane et al., 2012).*

P. 2710 Line 8: replace 'increasingly acknowledged' with 'important'.

Response: Replaced terms. *Over-grazed grassland soils are also an important sediment source (Bilotta et al., 2010) and critical to the transport of particle-bound pollutants, such as P (Haygarth et al., 2006).*

P. 2710 Line 15: slope length, steepness and shape are natural features and therefore refer to 'physiography' not 'topography'.
Response: Accept, this has been altered. *Erosion risk is conditioned by physical catchment characteristics (soil type and hydrology), and erodibility determined by physiography (slope length, steepness and shape, ground cover and soil management).*

P. 2710 Line 17: replace 'such that' with 'whereby'.
Response: Accept. *Soil drainage class, for example, is dictated by landscape position whereby well-drained soils, such as Brown Earths and Podzols commonly located on hillslopes, contribute sediment predominantly through sub-surface pathways.*

P. 2710 Line 22: replace 'is also suggested to' with 'can also'.
Response: Accept. *The installation of surface and sub-surface drains can also alter natural flow pathways (Ibrahim et al., 2013).*

P. 2710 Line 28: restructure sentence along the lines of the following:
Firstly, robust flow and sediment concentration data capable of accurately describing short-term fluxes (Navratil et al., 2011).
Response: Accept. *Firstly, robust flow and sediment concentration data capable of accurately describing short-term fluxes (Navratil et al., 2011).*

P. 2711 Line 4: replace 'recurrence interval' with 'frequency'.
Response: Accept. *Capturing crucial high magnitude, low frequency events is, therefore, vital to generating meaningful flux determinations (Walling and Webb, 1988; Wass and Leeks, 1999).*

P. 2711 Line 8-11: this sentence is cumbersome and lacks clarity - suggest rewrite.
Response: Accept sentence reworded. *Sediment load estimation based on SSC -discharge rating curves has been widely superseded by catchment outlet, near-continuous turbidity monitoring (Lewis, 2003; Jarstram et al., 2010; Melland et al., 2012a).*

P. 2711 Line 17-18: put citations in correct chronological order.
Response: Accept citations re-ordered. *There have been relatively few sediment flux investigations in Ireland (Melland et al., 2012a; Harrington and Harrington, 2013; Thompson et al., 2014).*

P. 2711 Line 21: should be 'Nitrates'.
Response: Accept. *In Ireland, soil conservation issues also fall under the Nitrates Directive regulations, but the impact of SS in rivers is commonly compared to the repealed FFD target due to the absence of explicit sediment targets within the WFD.*

P. 2712: Study Location possibly warrants a separate section, with section numbers amended thereafter.
Response: Accept- This section is now section 2, other following sections have been adjusted accordingly.

Materials and methods
Clearly written and presented – specific comments highlighted above.

Results and discussion
P. 2717 Line 8: change 'Jansson et al.,' to 'Jansson'.
Response: Accept. *This trend was not recorded at T_{OUT}, suggesting that the ex situ approach was less vulnerable to local in-stream debris interference (Jansson, 2002).*

P. 2718 Lines 3 and 4: rewrite to remove phrase 'suggested to' in both cases.
Response: Accept. *The greater density of sand particles compared to silts and clays can impact SSC and be oversampled by pumped samples such as the $ISCO_{IN}$ approach (Horowitz, 2008).*

P. 2719 Line 2: replace 'however' with 'although' and remove semi-colon.
Response: Accept. *This trend is repeated for the majority of samples at Arable B although some data points plot outside of the 95% confidence intervals for both in situ and ex situ method datasets.*

P. 2719 Line 28: are the authors referring to the FFD threshold? – in which case there is only one metric (25 mg L-1).
Response: Accept. *Although the instantaneous exceedance of the FFD metric have been reported in other sediment studies (Glendell et al., 2014; Peukert et al., 2014; Thompson et al., 2014), the transferability of this coarse threshold (compliance to which requires an undefined annual sample number) to high-resolution SS data is questionable.*

P. 2720 Line 2: this sentence needs to be more precise. The authors are referring to the FFD 25 mg L-1 threshold. There are not multiple thresholds.
Response: Accept, please see previous comment above for corrected sentence.

P. 2720 Line 11-14: use of parentheses is inconsistent in this sentence.
Response: Accept, this has been corrected. *Considering the agricultural intensity of these catchment, (for example, Grassland A is within the highest region of milk yield in Ireland (Läppe and Hennessy, 2012), and crop yields across Ireland are internationally high (Melland et al., 2012a)), these values are particularly low.*

P. 2720 Line 25: add 'at' before 'Grassland B' and remove semi-colon.
Response: Accept. *Total SSY data for individual years (Table 3), however, indicate variability and exceeded respective SSY target values at Grassland B in 2009 and 2012, Arable A in 2012 and Arable B in 2011 and 2012.*

P. 2720 Line 26: add 'in' before '2012'.
Response: Accept, please see previous comment above for corrected sentence.

P. 2721 Line 1: replace semi-colon punctuation with ', and'.
Response: Accept. *During rainfall events, soils are rapidly saturated and critical overland flow pathways established, and consequently, eroded particles within these connected areas are transported through the catchment (Mellander et al., 2012; Shore et al., 2013).*

P. 2721 Line 6: add 'e.g.' before 'Deasy' citation.
Response: Accept. *The SSC responses here suggest, as in other catchments with impeded drainage, that high overland-flow potential is also associated with a notable proportion of sediment delivered at lower concentrations over a longer period, through surface and sub-surface flow pathways (e.g., Deasy et al., 2009; Melland et al., 2012a) resulting in increased average SSCs.*

P. 2721 Lines 19 and 20: citations should be in parentheses.
Response: Accept. *Sediment delivery was enhanced by the combined effect of an overland-flow dominated transport system (poorly-drained soils) and, to a lesser extent, source availability (arable soils with potentially lengthy periods of bare ground cover (Regan et al., 2012) or seasonally thinly vegetated grassland soils (cf. Bilotta et al., 2010)).*

P. 2721 Line 24: replace 'however' with 'nevertheless'.
Response: Accept. *In catchments such as Arable A, where good-drainage is combined with high source availability, the risk associated with sediment transport during extreme rainfall events and years was, nevertheless, high.*

P. 2722 Lines 8-10: this sentence is cumbersome and lacks clarity - suggest rewrite.
Response: Accept. *Inter-annual SSY variability results from strong seasonality due to the timing and character of rainfall events, soil moisture deficit and land management which conditions sediment availability in critical source areas.*

P. 2722 Line 15: the phase 'seasonality of risk' although used in the literature does not read well in this sentence - suggest edit.
Response: Accept. *Additionally, assessment of seasonal transfers are likely to have greater ecological significance as mean annual thresholds such as SSC (through the FFD), and SSY may underestimate the seasonal fluctuations of risk of sediments to aquatic ecosystems (Thompson et al., 2014).*

P. 2723 Line 4: replace 'from' with 'with'.

Response: Accept. *However, even with modest SSY, the potential for other specific risks to ecologically sensitive habitats, from SS deposition in rivers for example, will need a cautionary approach.*

P. 2723 Line 8: replace 'will be' with 'is'.
Response: Accept. *Therefore, identification of the specific mechanisms promoting soil conservation or sediment retention in multiple catchments with contrasting physical and land use characteristics is important.*

Conclusion
The conclusions are quite detailed and are presented as bullet points, which does not appear to be consistent with the HESSD layout in other submissions.
Response: This format has previously been accepted in HESSD (e.g. Campbell et al., 2015) but we accept it is not a common practice. We shall therefore not alter these at the current time and, dependent upon the editor's decision regarding re-submission of the manuscript, will review this at a later date.

P. 2723 Line 21: this should probably be 'key findings are:'
Response: Accept. *The key findings are:*

P. 2724 Line 6: remove 'seasonality' from sentence, which is not necessary here.
Response: Accept. *Inter-annual variability of SSY was strong due to the timing and character of rainfall events in relation to land management.*

P. 2724 Line 14: remove 'coincident' from sentence, which is not necessary here.
Response: Accept. *Within the study catchments, SSY was higher in catchments dominated by poorly-drained soils than those with well-drained soils. Furthermore, on poorly-drained soils, catchments with a greater proportion of arable land use reported the highest annual average SSY.*

P. 2724 Line 16: 'sediment loss risk' is a cumbersome phrase, amend.
Response: Accept, sentence modified. *Well drained soils did, however, show the potential to supply significant quantities of sediment when extreme climatic conditions coincided with bare soils.*

P. 2724 from Line 26: this sentence is wordy and lacks clarity, rewrite.
Response: Accept sentence re-written. *Seasonal and storm-event scale sediment transfers may better inform erosion risk due to better detection of sediment pulses moving into the channel network particularly within ecologically sensitive periods.*

References
References have been checked with minor comments below.
P. 2725 Line 24: the title of the Brils (2008) article is incorrect, amend to '…the European Water Framework Directive…'
Response: Accept, this has been amended. *Brils, J.: Sediment Monitoring and the European Water Framework Directive, Annali dell'Istituto Superiore di Sanita 44, 218-223, 2008.*

P. 2727 Line 23: 'Geomorphology' should be 'Geomorph.'
Response: The journal policy seems to require the full title for this journal and is consistent with reference lists for other publications for HESSD.

P. 2730 Line 16: does TResearch refer to Teagasc Research? This may not be clear to non-Irish readers.
Response: Thank you for raising this point, however, the full name of the publication is TResearch. Although this is a Teagasc publication, 'TResearch' is not an abbreviation of 'Teagasc Research'

Tables
Table 1: this table could indicate which 3 decades the mean rainfall comes from.
Response: Clarification has been added to Table 1. The 30-year average corresponded to years 1981-2010.

Figures
Figure 1: the font size used on the location map and scale bar is too small.
Response: The font sizes have been increased for the scale bar and catchment names (i.e., text on location map) have been relocated in order to facilitate a larger text size.

Figure 1: the elevation scale is arbitrary and the gradient lacks clarity. Suggest amending to 0-250 m and clearly annotating elevation gradient scale.
Response: The scale has been altered, as suggested by the reviewer to 0-250 m and the colour ramp changed to more clearly show elevation.

Figure 2: increase the axes labels' font size.
Response: The font size has been increased on x- and y-axes.

Figure 3: the Arable A curve is not very clear on the graphs. The line width could be increased to improve clarity.
Response: The width for all lines has been increased and the Arable A curve has been further widened compared to the other catchments.

Figure 4: the mainland Atlantic Europe symbols obscure the UK and Ireland datasets. These could be open triangles and the Ireland data should be brought forward.
Response: Many thanks for this useful comment, the datasets have been rearranged to improve clarity.

Figure 4: the inter-annual ranges referred to on p. 2722 could be shown on this figure as minima and maxima for the Ireland data.
Response: Accept- Inter-annual ranges have been added to Figure 4.

References

Campbell, J. M., Jordan, P., Arnscheidt, J.: Using high-resolution phosphorus data to investigate mitigation measures in headwater river catchments, Hydrol. Earth Syst. Sci., 19, 453-464, 2015.

Deverell, R., McDonnell, K., Devlin, G.: The impact of field size on the environment and energy crop production efficiency for a sustainable indigenous bioenergy supply chain in the Republic of Ireland, Sustainability, 1, 994-1011, 2009.

Lal, R.: Effects of slope length, slope gradient, tillage methods and cropping systems on runoff and soil erosion on a tropical Alfisol: preliminary results, Proceedings of the Porto Alegre Symposium, December 1988, edited by Bordas, M.P. and Walling, D.E. , IAHS Publ., 174, 79-88, 1988.

Shore, M., Jordan, P., Mellander, P.-E., Kelly-Quinn, M., Melland, A.R.: An agricultural drainage channel classification system for phosphorus management, Agr. Ecosystems Environ., 199, 207-215, 2014.

Responses to reviewer 2 comments

We thank reviewer two for their time and detailed comments on our manuscript. Below, we have provided a point-by-point response to each of the reviewer's comments.

This manuscript was written for landscape managers interested in sediment management in agricultural catchments in Ireland. As a case in point, why should I as a scientist care whether these streams exceeded the repealed EU Freshwater Fish Directive mean annual suspended sediment concentration threshold of 25 mg/L?
Response: Exceedance of the EU Freshwater Fish Directive threshold has been previously used to indicate negative impacts of sediment on freshwater ecology (Thompson et al., 2014) and in turn the implications for achieving requirements of the EU Water Framework Directive. Therefore we use assess the proportion of time this threshold is exceeded to compare ecological risk between study catchments and also to figures published elsewhere in the literature (Thompson et al., 2014).

(1). Study location - There is a lot of information in this section on the specific types of soils, which if necessary would be best put in table 1 (i.e., Gleys, Podzols, etc.). Including this information in the text is a bit distracting and takes away from highlighting the most relevant catchment features: soil drainage class and land use. The amount of text on soil type versus the land use is unbalanced. I would like to know more about how intensive the agricultural practices are on each catchment. Can you quantify this by saying approximately how many cattle or sheep per acre are grazing in each catchment? This is really the key variable that will allow the reader to understand why sediment yield from these grazed catchments are "low" in terms of grazing intensity compared to other catchments in other parts of the world. On a related note from looking at table 1, what happens to the land used for growing winter (or spring) crops in the other seasons? Does it lay bare or is there some type of cover crop that would reduce soil erosion potential? This type of information on land use would be very valuable for better understanding the specific mechanisms governing sediment yield from these catchments rather than the general characteristics listed.
Response: The reviewer is correct that we provide a lot of information on soil properties. We believe this is necessary to adequately describe the soil drainage class, dominant flow pathways (a consequence of soil type), and additionally to describe the variability of soils within each catchment. Although generalisations are made about dominant flow pathways (Table 1), it would be inappropriate to not present these descriptions. We agree that more land use information will benefit the manuscript and we have, as suggested by the reviewer in later comments, including greater detail regarding stocking densities based on a catchment-scale average (see comment P 2712, L 14), ground cover and landscape complexity features. We have additionally included detail to the Arable catchment descriptions to indicate land management practices (or lack thereof) between cropping cycles.

Grassland A: Land is predominantly grazed by cattle for intensive dairy production and smaller areas of beef production with an average catchment stocking rate of 1.98 livestock units (LU) ha^{-1} additionally minor areas of arable land use are present (Table 1).

Grassland B: Land is predominantly grass-based for dairy and beef cattle grazing, and also sheep enterprises (Shore et al., 2013) with stocking rate of 1.04 LU ha^{-1}. Arable crops such as spring barley are common on the well-drained soils which are unmanaged between harvest and ploughing for following crop.

Grassland C: Land use is principally grass-based for dairy cattle, sheep and beef cattle grazing (stocking rate 1.00 LU ha^{-1}).

Arable A: Land use is dominated by spring barley (land is unmanaged between cropping cycles and crop rotation is limited) with areas of permanent grassland for beef cattle and sheep grazing in more poorly-drained areas (Melland et al., 2012a) at 0.40 LU/ha.

Arable B: Arable land is dominated by winter-sown cereals, but also comprises maize and potatoes. These areas are unmanaged between cropping cycles; however, crop rotation is more common than at Arable A due to the wider range of crop types. Additional areas of permanent grassland are utilised for dairy cattle, beef cattle, and sheep grazing (0.77 LU ha^{-1}).

(2). More information on the methodology and channel characteristics at the measurement sites is warranted to better assess the quality of the data collected. One aspect that would help, is listing the width of the channel at the measuring sections and possibly range of depths (within this context where exactly were the intakes/sensors located? Approximately X m above the bed and Y m from the bank). How do you know if your turbidity and suspended-sediment measurements are representative of the crosssection average values? You mention that you collected SSC across the cross-section but do not say anything about what you found regarding the cross-section variability. Typically to obtain truly representative samples, SSC or turbidity samples collected at one point in the river are corrected for how representative that point is of the crosssection averaged SSC at various flows (see Edwards and Glysson, 1999). There is not enough information in your methodology to assess whether these best practices for reducing the error in SSC measurement were followed. Also there is almost no information on your discharge measurements besides saying you installed a weir and measured stage. Did you collect discharge measurements to verify your rating curve?

Response: Information regarding the sensor positions have been added to the methodology. Added sentence: *"The turbidity sensor T_{IN} and the $ISCO_{IN}$ intake at Grassland B were approximately 20 cm above the channel bed and 15 cm from the bank edge. At Arable B, T_{IN} and the $ISCO_{IN}$ intake were positioned approximately 10 cm from the bank edge and 10 cm above the channel bed."* Additionally, figure A is now included in the manuscript which presents the cross-sectional depth-integrated data from Grassland B and Arable B catchments. These data show that cross-sectional variability was low. At Grassland B, the sampling transect conducted at the highest SSC (average SSC 484 mgL^{-1}) showed increased SSCs at the centre of the channel (consistent with greater velocity due to less frictional resistance) and lower SSCs to the right of the channel (horizontal distance greater than 300 cm). The left of the channel, where the T_{IN}, $ISCO_{IN}$ and the ex situ pump serving the bankside analyser, maintained a SSC close to the average value which validates these monitoring points as representative of the cross-sectional SSC transport. Clarification has also been added to the text regarding discharge measurements *"Synchronised discharge data (Q - $m^3 s^{-1}$) were calculated from vented pressure-transducer stage measurements (OTT Orpheus-mini; OTT Germany). Stage height was converted to Q using velocity-area measurements (OTT Acoustic Doppler Current meter; OTT Germany)collected over non-standard flat-v weirs (custom made, Corbett Concrete, Ireland) and WISKI-SKED software (Grassland A, R^2=0.96, n=272; Grassland B, R^2=1, n=166 (Mellander et al., 2015); Grassland C, R^2=0.95 and 0.97, n=316; Arable A, R^2=1, n=376 (Mellander et al., 2015); Arable B, R^2=0.94 and 1, n=493). Both Grassland C and Arable B had changing controls at higher discharges and WISKI-SKED provided two parts to the curves with two R^2 coefficients."*

(3). I would have liked to see discharge, turbidity (or SSC derived from turbidity), and SSC measurements plotted as a time series (if not for all sites then a few; and with data gaps shown where data gaps were encountered) to judge how well those individual measurements captured the range of flows/SSC for the year. You mention that your turbidity sensor was not working for certain periods of the year (either ISCO intake blocked or turbidity sensor saturated). When the turbidity sensor saturates (for your T_in) this is a problem because you are not capturing the SSC during the largest flows, which you point out are responsible for the largest sediment loads. How did you account for missing turbidity data in your estimate of SSY for each year? By showing your "raw" data it is easier for the reader to better understand how representative your measurements were in capturing, or not, all of the SSC variability throughout the year.

Response: Time series data of SSC as estimated by T_{IN} and T_{OUT} and discharge data of the two methodological comparison periods are shown in figure B. These data show the characteristics of SSC transfer (high magnitude and short duration SSC transfers) and clearly marked are periods of missing data with an explanation of the cause of missing data, e.g., saturation of T_{IN}, spurious peaks at T_{IN} and blocking of the ex situ instrumentation impacting T_{OUT}. Periods of missing data did not undergo any data correction as the objective was to compare the two turbidity-based SS sampling methodologies. No data correction was performed on missing data points in the longer-term data series from all catchments. Missing data were not accounted for in total load calcualtions. Periods of missing data are minimised due to communication system which alerts the technical support team should data collection cease. Further detail has been added to the text firstly to reference Figure B and secondly to indicate the duration of missing data periods due to system blockages.

Dataset completeness was similar in both T records (98-99%); however, the timing and nature of spurious and/or missing T data were dissimilar (Fig B).

Missing data at T_{IN} during periods of high sediment concentration was attributed to sensor saturation at Arable B. The T_{OUT} probe estimated 5% of the total sediment load was delivered whilst T_{IN} was saturated. Sporadically, pump blockages occurred in T_{OUT} at Arable B due to extreme debris transport in the channel (Melland et al., 2012b), data collection was ordinarily restored in less than 2 hr. At T_{IN} 6% of the total load was delivered during this period.

Detailed manuscript comments (Page, P; Line, L):

Title: This paper does not really identify the controls of soil loss but instead describes differences in suspended sediment yields from catchments of different soil drainage classes and agricultural land uses in Ireland.

Response: Title has been modified- *Investigating suspended sediment dynamics in contrasting agricultural catchments using ex situ turbidity-based suspended sediment monitoring*

P 2710, L 17: "Brown Earths" and "Podzols" are capitalized here but not at P 2712, L8. Suggest consistency of writing soil types here and throughout the manuscript.
Response: Capital letters have been added on P2712, L8: *Catchment soils are predominantly shallow well-drained Brown Earths and Podzols with loam dominating the texture of A- and B- horizons, and smaller areas of surface-water Gleys at the base of hillslopes.*

P 2710, L 19: How do soils contribute sediment through sub-surface pathways? Is fine sediment really moving through soil pore spaces? Or do you mean sediment entering sub-surface drain tiles? Or do you mean through bedrock fissures and karst? Please be more specific.
Response: Clarification has been added here. *Soil drainage class, for example, is dictated by landscape position whereby well-drained soils, such as Brown Earths and Podzols commonly located on hillslopes, contribute sediment predominantly through sub-surface pathways such as relocation of fine surface sediments vertically and/or horizontally through the soil profile and preferential flow through macropores (Chapman et al., 2001; Deasy et al., 2009).*

P 2712, L 5: Why were these 5 catchments chosen?
Response: Explanation of study catchment selection has been added: *Catchments were selected to represent the main intensive agricultural land use types in Ireland, dominant hydrological pathways (surface or sub-surface) at a scale where headwater to channel hydrological process were detectable (Fealy et al., 2010). The characteristics of individual catchments are summarised as follows:*

P 2712, L 5: Reference table 1 here?
Response: Reference to table added here. *Suspended sediment monitoring was conducted in five catchments (Table 1) across Ireland (Fig. 1).*

P 2712, L 14: How intensive? Can you say how many cattle per acre of land?
Response: Yes we have added the average catchment stocking rate for 2008-2014 to the study location description.

Grassland A: Land is predominantly grazed by cattle for intensive dairy production and smaller areas of beef production with an average catchment stocking rate of 1.98 livestock units (LU) ha^{-1} additionally minor areas of arable land use are present (Table 1).

Grassland B: Land is predominantly grass-based for dairy and beef cattle grazing, and also sheep enterprises (Shore et al., 2013) with stocking rate of 1.04 LU ha^{-1}.

Grassland C: Land use is principally grass-based for dairy cattle, sheep and beef cattle grazing (stocking rate 1.00 LU ha^{-1}).

Arable A: Land use is dominated by spring barley (land is unmanaged between cropping cycles and crop rotation is limited) with areas of permanent grassland for beef cattle and sheep grazing in more poorly-drained areas (Melland et al., 2012a) at 0.40 LU/ha.

Arable B: Additional areas of permanent grassland are utilised for dairy cattle, beef cattle, and sheep grazing (0.77 LU ha^{-1}).

P 2713, L 1: Grassland C is listed as being located in "north-central Ireland" whereas Arable B is listed as being located in "east-central Ireland." From the dots on the map of Ireland in figure 1, these catchments both appear to be located in the same region, maybe north-east Ireland. I suggest changing the description of these two catchment locations so they are consistent.
Response: The locations of the catchments have been edited accordingly:

Grassland C catchment (3.3 km^2) is located in north-east Ireland (54°10'N, 6°51'W).

Arable B catchment (9.5 km^2) is located in north-east Ireland (53°49'N, 6°27'W).

P 2713, L 17: Beef (or dairy for that matter) does not use the grassland. The grassland is used by cattle that are raised for beef. Suggest changing “beef” to “cattle”.
Response: Clarification has been added in the study location information for all catchments.

Grassland A: Land is predominantly grazed by cattle for intensive dairy production and smaller areas of beef production with an average catchment stocking rate of 1.98 livestock units (LU) ha^{-1} additionally minor areas of arable land use are present (Table 1).

Grassland B: Land is predominantly grass-based for dairy and beef cattle grazing, and also sheep enterprises (Shore et al., 2013) with stocking rate of 1.04 LU ha^{-1}. Arable crops such as spring barley are common on the well-drained soils which are unmanaged between harvest and ploughing for following crop.

Grassland C: Land use is principally grass-based for dairy cattle, sheep and beef cattle grazing (stocking rate 1.00 LU ha^{-1}).

Arable A: Land use is dominated by spring barley (land is unmanaged between cropping cycles and crop rotation is limited) with areas of permanent grassland for beef cattle and sheep grazing in more poorly-drained areas (Melland et al., 2012a) at 0.40 LU/ha.

Arable B: Arable land is dominated by winter-sown cereals, but also comprises maize and potatoes. These areas are unmanaged between cropping cycles, however, crop rotation is more common than at Arable A due to the wider range of crop types. Additional areas of permanent grassland are utilised for dairy cattle, beef cattle, and sheep grazing (0.77 LU ha^{-1}).

P 2713, L 28: Why should the reader care whether land is used by cattle for beef or dairy? Is there something about their grazing habits that is different for cattle raised for beef than cattle raised for dairy? Also can you say whether cattle or sheep on a landscape would generally contribute to more sediment erosion based on their grazing practices?
Response: We divide these livestock groups as each group (dairy cattle, beef cattle and sheep) can be expected to impact soil erosion potential differently. Firstly, cattle have a greater mass to hoof surface area ratio (or hoof loading) than sheep. This results in a greater application of force onto the land surface and a greater impact on profile degradation (Betteridge et al., 1999) particularly poaching around feeders and water troughs which are frequently accessed (Herbin et al., 2011; Tuohy et al., 2014). Furthermore, dairy cattle are moved around farms more frequently due to the twice-daily milking regime. This increases the likelihood of soil degradation around gateways and un-metalled tracks. Compaction or destruction of natural soil structure decreases infiltration capacities of soils therefore increasing the likelihood of surface water transport and associated erosion and transport of particles by raindrop impact. Natural recovery of soils by vegetation is additionally likely reduced as damaged soils are prone to waterlogging and the closed structure prevents root establishment. Additionally, sheep are commonly grazed outdoors all year in Ireland whereas cattle are housed during winter for between three and five months of the year (Melland et al., 2012a). The periods of exposure of soil to livestock and therefore the potential impact on soil erosion are therefore seasonally variable.

P 2714, L 12: Can you provide more information on how you obtained and verified your discharge data? Did you collect flow measurements at the weir to verify the stage discharge relationship?
Response: Clarification has been added here: *Synchronised discharge data (Q - $m^3 s^{-1}$) were calculated from vented pressure-transducer stage measurements (OTT Orpheus-mini; OTT Germany). Stage height was converted to Q using velocity-area measurements (OTT Acoustic Doppler Current meter; OTT Germany)collected over non-standard flat-v weirs (custom made, Corbett Concrete, Ireland) and WISKI-SKED software (Grassland A, R^2=0.96, n=272; Grassland B, R^2=1, n=166 (Mellander et al., 2015); Grassland C, R^2=0.95 and 0.97, n=316; Arable A, R^2=1, n=376 (Mellander et al., 2015); Arable B, R^2=0.94 and 1, n=493). Both Grassland C and Arable B had changing controls at higher discharges and WISKI-SKED provided two parts to the curves with two R^2 coefficients.*

P 2714, L 16: What exactly was regular about the “regular low-flow samples”? And what is intensive and discrete about samples collected at the “intensive, discrete, high magnitude flow events” that was not intensive and discrete about the low-flow samples?
Response: The phrase “regular low-flow samples” referred to (at least) fortnightly samples taken from the instrument tank for the length of the monitoring programme. The word intensive referred to the greater frequency of water samples collected during storm events referred to at P 2714, L17-20. The reviewer is correct,

all samples were discrete, therefore, this word has been omitted as a description for storm event samples. Clarified sentence now reads: *Turbidity units (NTU) were field-calibrated to SSC (mg L^{-1}) using a combination of regular low-flow samples (at least fortnightly since programme initiation) and intensive sampling during high magnitude flow events with elevated SSCs.*

P 2714, L 21: Define what you mean by “turbidity-stratified sampling programme.” Something like . . .turbidity-stratified sampling programme, where X volume samples were collected every Y minutes when the turbidity reading exceeded Z, thus circumventing. . .
Response: This programme triggered the ISCO sampler to take one sample (1 litre) when the turbidity sensor measured within threshold turbidity bands; 140 to 160 NTU; 240 to 260 NTU; 480 to 530 NTU and 700 to 800 NTU. The width of the bands was increased at higher turbidities to account for this range being short-lived at both rising and falling water levels. This information has been added to the text:
High SSC data capture was further targeted in Grassland B and Arable B using a turbidity-stratified sampling programme, whereby collection of 1000 ml samples were triggered when T measurements were within threshold turbidity bands of 140 to 160 NTU, 240 to 260 NTU, 480 to 530 NTU and 700 to 800 NTU.

P 2715, L 6: I do not understand why this comparison necessitated deploying a second ISCO sampler next to the in situ turbidimeter? From my understanding of this comparison you have two ISCO samplers (which are really both deployed ex situ, it is just that the one is used to obtain sediment to compare to the in situ turbidimeter) a turbidimeter (ex situ) deployed in an instrument kiosk on the bank next to the ISCO sampler and another turbidimeter (in situ) deployed within the stream near the ISCO_in intake. Why did you not just deploy the in situ turbidimeter near the intake of the ISCO_out and use those sediment samples to calibrate both turbidimeters? The only real usefulness that I can see for having the two ISCO samplers is to see if the length of the intake tube affects the measurements.
Response: The reviewers comment has indicated that our experimental set-up may not have been as clearly described as we originally intended. We have included figure C to clarify the instrumentation approach. River water is continuously delivered to the ex-situ instrument tank by a large capacity pump (30 m^3 hr^{-1}), the ex-situ turbidimeter and ex-situ ISCO sampler ($ISCO_{OUT}$) collect samples from this instrument tank. The in-situ tubidimeter and $ISCO_{IN}$ intake is, as the reviewer suggests, installed in the channel, therefore, there is a clear methodological difference between the in-situ and ex-situ instrumentation, namely the high capacity pump in between. Furthermore as noted by the reviewer, the length of the ISCO intake tubes also differ (queries regarding intake tube length tests are further addressed in later comments please see P 2718, L 15). Comparisons are therefore made between SSC samples taken at $ISCO_{IN}$ and $ISCO_{OUT}$ locations.

P 2715, L 7: What was the approximate distance specifically? 10 cm? 1 m?
Response: The in situ turbidimeter (T_{IN}) was positioned approximately 1 m away from the pump serving the ex situ bankside analyser. The in situ ISCO intake ($ISCO_{IN}$) was approximately 4 m from the ex-situ pump intake, (i.e., 3 m from the in situ turbidimeter T_{IN}). This information has been added to this sentence: *A turbidimeter (T_{IN}) (Analite, McVan, Australia, range 0-1000 NTU) and automatic pumping sampler ($ISCO_{IN}$) intake were positioned in situ, adjacent to the channel edge, in proximity to the bankside analyser pump intake (1 m and 4 m upstream, respectively at both study catchments), but sufficiently distant not to affect, or to be affected by the ex situ instrumentation.*

P 2715, L 15: You collected 225 depth-integrated samples but I do not see 225 depth integrated points in Figure 2. Did you composite the samples somehow? Figure 2 says the samples were averaged, in what way exactly?
Response: The individual depth-integrated sediment samples have replaced the averaged values on Figure 2. In relation to your later comment with regard to P 2716, L 15, the rating curve equations and fit parameters have also been added to the figure.

P 2715, L 16: What about during non-flood events, such as at low flows?
Response: A transect of depth-integrated measurements was collected at baseflow at Grassland B before commencing the method comparison experiment. These data showed that variability was low; average concentration 1.57 mg/l, minimum 0.5 mg/l and maximum 2.5 mg/l. Therefore, it was decided that high concentration event transfers should be targeted during the study.

P 2715, L 22: How wide are the channels I wonder (please add to study site or table 1)? For (2): How much coarser, please specify at least a rough measure, 1m? Were the samples from (2) depth-integrated? You mention the samples in (2) are taken from multiple depth positions; are these at-a-point samples? If so at what depths?

0.2, 0.6, and 0.8 depth? If at-a-point how do you collect samples at multiple depths with a depth-integrating sampler? You must have used a different sampler? The U.S. Geological Survey has conducted substantial research on how most accurately to measure SSC using physical samplers, I am trying to determine by reading your methods how consistent your methods are with established best practices for reducing measurement error as described in Edwards and Glysson (1999).
Response: Channel cross-sections have been added to new figure A (see comment regarding on cross-sectional variability of data- P2717, L 25 and P2718, L 16). Coarser widths were at 1 m increments, at-a-point samples have been removed from analysis as the reviewer is correct that these cannot be sampled using a depth-integrated sampler. Clarification about coarser widths has been added, sentence now reads: *Samples were collected using two strategies; 1) depth-integrated samples taken at 20 cm intervals across the channel width in rapid succession, and 2) samples taken at coarser widths intervals roughly 1 m.* Accordingly, the total number of depth integrated samples stated in P 2715, L15 has been edited, sentence now reads: *Depth integrated water samples were manually collected (n=171) from a bridge over each investigated channel during flood events, using a depth-integrating SS sampler (US DH-48, Rickly Hydrological; USA).*

P 2715, L 24: How long did it take you to measure SSC on these streams and how fast were conditions changing?
Response: The change in SSC over the time taken to complete the depth-integrated transect, as measured by the ex situ turbidimeter, was 0.1 – 81.94 mg/l (average 16.3 mg/l). The average time taken to complete the sampling transect was 22 min (range 12-28 min). This is a SSC change of 0.005-6.8 mg/l per min. We have added clarification to the text in response to this comment after P 27151, L 26: *The average change in SSCs during transects at T_{OUT} was 16.3 mg/l (range 0.1 – 81.94 mg/l) and average transect time was 22 mins.*

P 2716, L 15: I did not see the results from this comparison analysis of the two curve fits to the data. In addition I did not see the parameters that were actually fit to the data or the form of the equations shown in Figure 2 or for estimating the final SSC and SSY for all catchments. Please mention the rating curves that were selected, the parameters of the curve, and the quality of the fit.
Response: Please refer to earlier comment (P2715, L15) regarding Figure 2. Detail has been added to the text regarding the selection of rating curve form and reference is made to an additional data table A summarising turbidity-SSC calibration in all catchments. *Power relationships provided the best fit in Grassland A, Grassland B, Grassland C and Arable A, whereas the split linear relationship considerably improved fit at Arable B (Table A).*

P 2717, L 16: Here you allude to sub-weekly maintenance of the turbidity sensors. The specifics of what you do during this maintenance should be mentioned in the methods section. Specifically, I am curious what you do to ensure the turbidity sensor does not experience biological fouling, do you stop data collection, do you clean the sensor, do you switch the sensor out for a different instrument?
Response: All turbidity sensors were fitted with wipers to prevent biological-fouling. Information has been added to the text: *Turbidity probes were fitted with wipers to prevent biological fouling, and checked monthly against deionised water (0 NTU) and a 20 NTU Formazin turbidity standard.*

P 2717, L 25: Here is why knowing more about the distance between ISCO intakes and cross-section variability of SSC are important! Are the sampling intakes far enough apart that cross-sections and cross-section variability of SSC between these two intake sites are different? I understand that the difference is not statistically significant but you mention that this difference is a bias between instruments that should be explained somehow.
Response: Please refer to figure A (see comment regarding P 2715, L 22) which shows that cross-sectional variability is generally low. Therefore, we do not believe that, in the 4 metre distance between the $ISCO_{IN}$ intake and the bankside analyser pump, a significant change in cross-section SSC distribution would occur that would explain a consistent bias through the range of SSCs measured. We collected cross-sectional SSC measurements from the bridge over the channel as shown in Figure C (i.e. between the two intakes). The corresponding horizontal position of each intake ($ISCO_{IN}$ or the pump serving the bankside analyser and ex situ instrument tank- Figure A) shows no consistent step change in SSC over the range of transects measured at Grassland B. The coarser measurements used at Arable B of course makes the same comparison in this catchment unobtainable. We hope that by better clarifying the instrumentation set up (comment regarding P 2715, L 6) it is clearer to the reviewer that the main difference is the additional methodological step performed to transport the river water to the ex situ instrument tank.

P 2718, L 5: I do not doubt that the percentages of sand in suspension measured by ISCO_in versus ISCO_out would be that much different. The comparison you are making here misses the point of Horowitz (2008) that

you bring up. Horowitz mentions that ISCO samplers tend to over sample sand compared to conventional depth-integrating samples (such as the DH-48 that you use). Thus you should be comparing the concentration of sand measured by the ISCO samplers to the concentration of sand measured by the depth-integrated sampler.
Response: We were unable to compare particle size of ISCO samplers and depth-integrated samples due to the insufficient sample volume of DI samples after SSC analysis. We therefore do not attempt to compare the $ISCO_{IN}$ or $ISCO_{OUT}$ samples to the depth-integrated rather we are comparing SSC results from $ISCO_{IN}$ and $ISCO_{OUT}$. As there is a methodological difference between these two collection points (in-stream pump delivering river water to the instrument tank where the ISCO sampler is collected from) we considered that the elevated %sand due to contrasting sampling techniques was likely similar to the factors that caused the differences found by Horowitz (2008) and may therefore explain differences here.

P 2718, L 9: The statement here that "the hypothesis that inadequate sample collection using either method [both ISCO sampling methods] could affect SSC is unlikely" is not justified by the comparisons made. You need to compare SSC measured by the ISCO sampling method to SSC measured using the depth-integrating sampler or non-ISCO pumped samples.
Response: As stated in the previous comment response (P 2718, L 5), there was inadequate sample volume to process depth-integrated samples for particle size distribution so comparisons between $ISCO_{IN}$, $ISCO_{OUT}$ and depth-integrated samples could not be made. Here we are referring to the differences in SSC between $ISCO_{IN}$ and $ISCO_{OUT}$ methodologies, P 2718, L 9 has been edited to better clarify this: *The hypothesis that inadequate sample collection could affect the differences between SSCs at $ISCO_{IN}$ and $ISCO_{OUT}$ is unlikely, as contrasts between the sand-sized fractions seemed to be event specific.*

P 2718, L 11: This is interesting! You are saying that you collect a smaller proportion of sand in SSC as discharge increases. I would like to see you expanded on this finding in the results/discussion. I would like to see this data in a figure and have you discuss whether you think this is because that is how the landscape behaves or because there is an issue with how the ISCO collected sand (did the depth-integrated samples show this?) or because the cross section variability of sand changes with discharge? This should be further discussed because it is not consistent with most studies or understanding.
Response: Again, we were unable to compare particle size data from $ISCO_{IN}$ and $ISCO_{OUT}$ to depth-integrated samples. Although it is an interesting point, this finding was not a principal aim of this study and would require further data collection and analysis to expand upon this finding. We have therefore removed this sentence from the manuscript.

P 2718, L 15: I think this is the only place that the results of the pump length comparison test is discussed. How much different were the 1m versus the 7m tube lengths for SSC? I understand the difference is not significant but is there a bias that might help explain the also insignificant bias of measured SSCs between ISCO samples?
Response: The tube length test results (Figure D) showed a bias at 5 mg L^{-1} SSCs whereby the samples taken by the ISCO with the 7 m tube length had a greater concentration and were less accurate than the 1 m tube length samples. This trend was present but less extreme at 10- 25- and 50-mg L^{-1}. The bias was not, however, consistent at SSCs ≥100 mgL^{-1}, therefore, we could not attribute differences between results to the pump length of the ISCO water sampler.

P 2718, L 16: "It is possible. . ." why not state based on data whether this is the case or not? You measured SSC every 20 cm along the channel correct? So you have a measure of how variable SSC is throughout the cross section at various flows.
Response: The cross-sectional data presented in Figure A (see comment P 2715, L 22) did not report an elevated SSC at the $ISCO_{IN}$ intake and based on these data we could not confidently conclude this is the case. At P 2718, L17 we are speculating that the pumping procedure of the ISCO itself could potentially draw particles from the channel bank (despite the intake being positioned ~15 cm in-stream from the base of the channel bank) or the additional methodological step to transport river water to the ex situ instrumentation influences SSC. As we can confirm neither using our data, these are speculative points only.

P 2719, L 12: Fig. 3 does not provide any information on the (short) duration of high magnitude SSC events. You cannot tell from this plot whether there were 10 high magnitude events of relatively short duration or 2 high magnitude events of relatively long duration that contribute to the small fraction of total time exceeding a given concentration. This figure only shows the percentage of time high magnitude SSC occurred. That is, Fig. 3 shows that high magnitude events are infrequent. Throughout this paragraph you refer to shorter duration or shorter periods when what the figures show are frequency of occurrence or percentage of time.
Response: The reference to Figure 3 has been relocated to the end of this sentence to support the comment that high magnitude SSCs are critical to annual SSY. A reference to Figure B has been added after the comment that

"high magnitude SSCs were of short duration in all five catchments.*"* The sentence now appears as follows: *High magnitude SSCs were of short duration in all five catchments (e.g. Fig B for Grassland B and Arable B), but such periods are typically critical to cumulative annual SSY (Fig. 3b - Walling and Webb, 1988; Navratil et al., 2011).*

P 2719, L 17: Roughly 25-40% of the time, not 50%!
Response: The proportions have been corrected and the sentence now reads: *In the remaining catchments, low concentrations of <1 mg L^{-1} were more common and occurred between 25 and 40% of the time.*

P 2719, L 19: More like 5-8%, or you could say "were limited to less than 10% of the monitoring period."
Response: We have amended this sentence as follows: *High concentrations (≥10 mg L^{-1}) were limited to less than 10% of the monitoring period.*

P 2719, L 26: What is it about these catchments that make them "predominantly improved"? This is the necessary insight as to why your grassland study catchments have "low" sediment yields. Do these "improved" catchments have fewer animals grazing, where there other measures taken that reduce sediment yields? Please mention what the factors are for these two catchments and whether your grassland catchments have the same factors. You mention later in this sentence the soil drainage class for these catchments but are these the "improvements" that you are referring to?
Response: In this case, "predominantly improved" infers that the land is more intensively managed to increase grass yield. This can include installing artificial drainage systems (in field and open ditches to improve trafficability and grass utilisation) to reduce waterlogging (by dropping the water table and increasing the storage capacity of the soil profile to accept rainfall) and increase the utilisable land area (for longer periods into the grazing season) in a catchment, and fertilisation ordinarily of nitrogen and phosphorus to increase grass yield for silage, hay or direct grazing by livestock. The catchments are therefore "improved" to maintain a greater agricultural output. The comment made here by the authors therefore refers to an agricultural management system which would be likely to increase the sediment yields. We see that this term may not be clear to the wider audience and have replaced it with "intensively managed grassland". *The values here are similar to those reported by Thompson et al. (2014) in two other intensively managed grassland catchments in Ireland; 8% exceedance was reported in a moderately-drained catchment in Co. Down and 18% exceedance in a poorly-drained catchment in Co. Louth.*

P 2720, L 14: This sentence contains valuable information I would have liked to read earlier on in the section on study catchments. Can you show an aerial photo of these irregularly shaped fields so the reader can obtain a better sense of this? This is a very important statement for helping other landscape managers control sediment in their catchments in other parts of the world. Helping translate this in an image would help landscape managers understand what it might take for their agricultural landscapes to have lower sediment yields. An image would also be valuable to better translate what you mean by "complexity of landscape features" and how they are laid out spatially.
Response: Field boundaries have been added to Figure 1 to visually show the complexity of the landscape. Additionally, landscape complexity features; average field size, hedgerow density, average maximum downslope length and density of drainage ditches have been added to Table 1.

P 2720, L 20: On average here being the 4-year average correct? Compared to the 1-year averages mentioned at line 25? If Cooper et al. (2008) suggests "annual target and threshold investigation SSY values" then why compare the 4-year averages and not just the 1-year averages?
Response: The Cooper et al. (2008) target and threshold values were developed using annual average data primarily from lake cores. The sentence has been modified to better clarify this point: *In the UK, Cooper et al. (2008) suggested annual average 'target' and threshold 'investigation' SSY values be based upon drainage class and catchment terrain characteristics.* By averaging the annual data points available (3 years in Grassland A and Grassland C and 4 years in Grassland B, Arable A and Arable B) we make the best comparison available. To further assess the variability in the data set we go on to discuss individual year SSYs, or as the reviewer refers to them "1-year averages".

P 2721, L 6: What do you mean by sediment delivered through sub-surface pathways? Is it that fine sediment is moving from the surface of the fields through pores in soil? Or is this related to sub-surface tile drainage? Or is this through bedrock pores or karst?
Response: Clarification has been added here. *The SSC responses here suggest, as in other catchments with impeded drainage, that high overland-flow potential is also associated with a notable proportion of sediment delivered at lower concentrations over a longer period, through surface and sub-surface flow pathways such as*

through macropores and tile drains (e.g., Deasy et al., 2009; Melland et al., 2012a; Mellander et al., 2015) resulting in increased average SSCs.

P 2721, L 11: Table 3 says poorly-drained for soil drainage class for Grassland C, not moderate- to poorly-drained as the text here states.
Response: We presume the reviewer intended to refer to Table 1 here. In Table 1, the dominant soil drainage class for Grassland C and Arable B were unintentionally switched, this has been corrected and the table is now consistent with comments made in the text.

P 2721, L 15: Did you normalize for differences in rainfall from catchment to catchment from year to year for your comparisons? It appears from table 3 that there are moderate variations from year to year in magnitude of change in rainfall when comparing the yearly changes between catchments.
Response: We did not normalise these data by rainfall or discharge.

P 2721, L 25: A very important statement for management.
Response: Thank you.

P 2721, L 28: What is CV%? Coefficient of variation? Please define.
Response: The definition has been added to the sentence: *The annual SSY coefficient of variation (CV%) were 67%, 76%, 79%, 83% and 50% in Grassland A, Grassland B, Grassland C, Arable A and Arable B, respectively.*

P 2722, L 13-24: Good points! Very important for managers.
Response: Thank you.

P 2722, L 24: Time lag of what?
Response: The authors refer here to the time lag of water quality response to catchment mitigation measures, this has been clarified in the text. *This task is particularly complicated where ecological condition is subject to multiple-stressors such as nutrients (Bilotta and Brazier, 2008), bed substrate quality (Kemp et al., 2011) and time lag of water quality response to land-based pollutant mitigation measures (Fenton et al., 2011; Vero et al., 2014).*

P 2724, L 9: “Equivalent catchments and landscape settings”? The only discerning factors are catchment size and country in Figure 4.
Response: The wording has been changed, sentence now reads: *Average annual SSYs in all five Irish catchments reported here were low in comparison to similar catchment and landscape settings elsewhere in Europe.*

P 2724, L 9: Spelling, “settings” not “settlings”?
Response: Accept- spelling mistake corrected.

P 2724, L 12: Should be “was [generally] higher.” It is important to clarify this as a general statement because this is not so for all study catchments with poorly-drained soils.
Response: The revision of Table 1 (comment P 2721, L 11) supports that this statement is, as intended, correct.

P 2724, L 16: Where/how is this shown exactly in the paper? How do we know the timing of when the soils were bare in comparison to extreme climatic conditions?
Response: The reviewer is correct here, this conclusion is not supported by data presented in the paper. The sentence has been modified in line with data presented (and further comments by reviewer 1) as follows: *Well drained soils dominated by arable crops did, however, show the potential to supply significant quantities of sediment.*

P 2724, L 25: Why do “key questions still remain regarding the magnitude and frequency characteristics of sediment transfer at shorter timescales”? You have the continuous turbidity and thus continuous SSC data. With this data why do you not say something about the magnitude and frequency characteristics of sediment transfers at shorter timescales?
Response: The intended point has been clarified here, sentence now reads: *Whilst the current SSYs are low by international standards, key questions still remain regarding the impact of land use on the magnitude and frequency characteristics of sediment transfers at shorter timescales.*

Table comments (Table, T):

T 2: T_in saturated at 1000 NTU, can you translate this to SSC at these sites so the reader can be aware of how frequent this sensor was being saturated? Did you do any corrections to the data to account for when the turbidity sensor was saturated and thus unable to provide an accurate measurement? Furthermore, how could you report accurate total loads/yields and mean concentrations if your T_in sensor does not provide information on the highest concentrations, which contribute the most sediment to the total loads? What is more bothersome is why this is not mentioned in the text.

Response: The SSC at the point of T_{IN} saturation is already provided in Table 2 in the final column. In Grassland B, the T_{IN} sensor did not report any measurements over 1000 NTU during the monitoring period, therefore, the maximum T value recorded was equivalent to a converted SSC value (using the rating curve specified in Fig 2b) of 1188 mg L^{-1}. At the Arable B catchment the T_{IN} sensor did saturate and, using the rating curve presented in Fig 2d, the maximum 963 NTU measured corresponds to the 823 mg L^{-1} presented in the final column of Table 2. The addition of Figure B reports the frequency of T_{IN} saturation, we did not deem it appropriate to correct these data points where the aim of the study was to compare SSC measurement methodologies. The period of data collection where T_{IN} was saturated (in combination with removed spurious peaks accounting for the 1-2% of missing data referred to at P 2717, L 3) accounted for 5% of the total load using T_{OUT}. The impact of saturation in this case at T_{IN} can therefore be considered low. We have clarified our approach in the methods section: *T-SSC rating curves were developed for each sensor using water samples collected at the respective positions ($ISCO_{OUT}$ and $ISCO_{IN}$) and applied to the raw turbidity set. Low quality data capture attributed to spurious peaks, saturation of the T_{IN} sensor or missing data at T_{OUT} due to delivery system blockages did not undergo correction such that comparisons between methodologies could be made.*

Figure comments (Figure, F):

F 1: It would be nice to see a scale on the Ireland map. Otherwise it is hard to tell how large these catchments are compared to Ireland. Also the text in this figure is too small to read, I can only see which catchments are which by zooming in really far into this figure. I would instead suggest labeling the zoomed in catchments (with large text size) rather than on the Ireland map so then it is easiest to quickly see which catchments are which. The dotted line then connects the location of the catchment to the location in Ireland for the reader. The names of the catchments are also followed by what appears to be the nearest city/town name. I suggest identifying this additional information as in fact nearby cities in at least the caption if not also the text. I am unable to find Corduff, Ireland at the location pointed out on the map if these names are in fact cities. Corduff appears to be a suburb of Dublin. What is it that Corduff describes?

Response: The graphics on Figure 1 have been updated to relocate and increase the size of the text, and include a scale bar for the Ireland insert. The catchment names following the ‘Grassland A’, ‘Grassland B’… text are, as the reviewer suggests, the closest village to the study catchment which are used in some publications including the website. As these are not referred to again in the manuscript they have been removed from this figure to remove confusion. There are many towns called Corduff in Ireland, we sought to differentiate Corduff, Co. Monaghan by referencing the northing/easting location of the catchment in the study description (P 2713, L 1).

F 2: Again text is too small to read easily. Can you report the equations used to fit the data?

Response: This figure has been redrawn to increase text size and incorporate changes in relation to comment (P 2715, L 15).

F 3: (a) y-axis should be something like, “Percentage of time SSC exceeded” (b) yaxis should be something like, “Cumulative distribution of the percentage of total SSY contributed by a given SSC”

Response: The y-axes titles have been replaced for figure 3a) as recommended by the reviewer, and figure b) to “cumulative percentage of total SSY (%)”. Additionally the figure caption has been updated: Figure 3. *Frequency-duration graphs of, a) suspended sediment concentration exceedance with time and, b) Cumulative percentage of suspended sediment yield with exceedance of suspended sediment concentration.*

F 4: I would put the black filled circles and black unfilled squares on top of the gray filled triangles so more of the data can be easily seen. I see a lot of squares hiding behind the triangles.

Response: The display of datasets has been improved and range of annual SSYs (from individual years) added to the study catchment data (following comment from reviewer 1).

F 5: Why not put actual values on the x-axis – 100% grassland to 100% arable? You have the numbers. Is this diagram truly conceptual or is it based on the data? The values on the contours and the fact that you have data suggest that this figure was based on the data. How were the contours determined and what values were used to place the points (the 4-year averages)?

Response: The axes ranges have been amended based on the reviewer's suggestion. The diagram used data collected in this study but the contours were not modelled hence why we used the term "conceptual". As stated in the text P 2721, P 15 "*Inter-catchment comparisons used data from hydrological years 2010 to 2013, where data were available for all five catchments*". To better clarify this sentence is related to the previous sentence we have inserted the word "here", the passage now reads as follows (P 2721, L14-16): *Generalisations can be made in relation to the overriding controls on SSY across the monitored catchments (Fig. 5). Inter-catchment comparisons here used data from hydrological years 2010 to 2013, where data were available for all five catchments.*

References

Betteridge, K., Mackay, A.D., Shepherd, T.G., Barker, D.J., Budding, P.J., Devantier, B.P., Costall, D.A.: Effect of cattle and sheep trading on surface configuration of a sedimentary hill soil, Aust, J. Soil Res., 37, 743-760, 1999.

Fealy, R.M., Buckley, C., Mechan, S., Melland, A.R., Mellander, P.-E., Shortle, G., Wall, D., Jordan, P.: The Irish Agricultural Catchment Programme: catchment selection using spatial multi-criteria decision analysis, Soil Use Manage., 26, 225-236, 2010.

Herbin, T., Hennessy, D., Richards, K.G., Piwowarczyk, A., Murphy, J.J., Holden, N.M.: The effects of dairy cow weight on selected soil physical properties indicative of compaction, Soil Use Manage., 27, 36-44, 2011.

Tuohy, P., Fenton, O., Holden, N.M., Humphreys, J.: The effects of treading by two breeds of dairy cow with different live weights on soil physical properties, poaching damage and herbage production on a poorly drained clay-loam soil, J. Agri. Sci., DOI: http://dx.doi.org/10.1017/S0021859614001099, 2014.

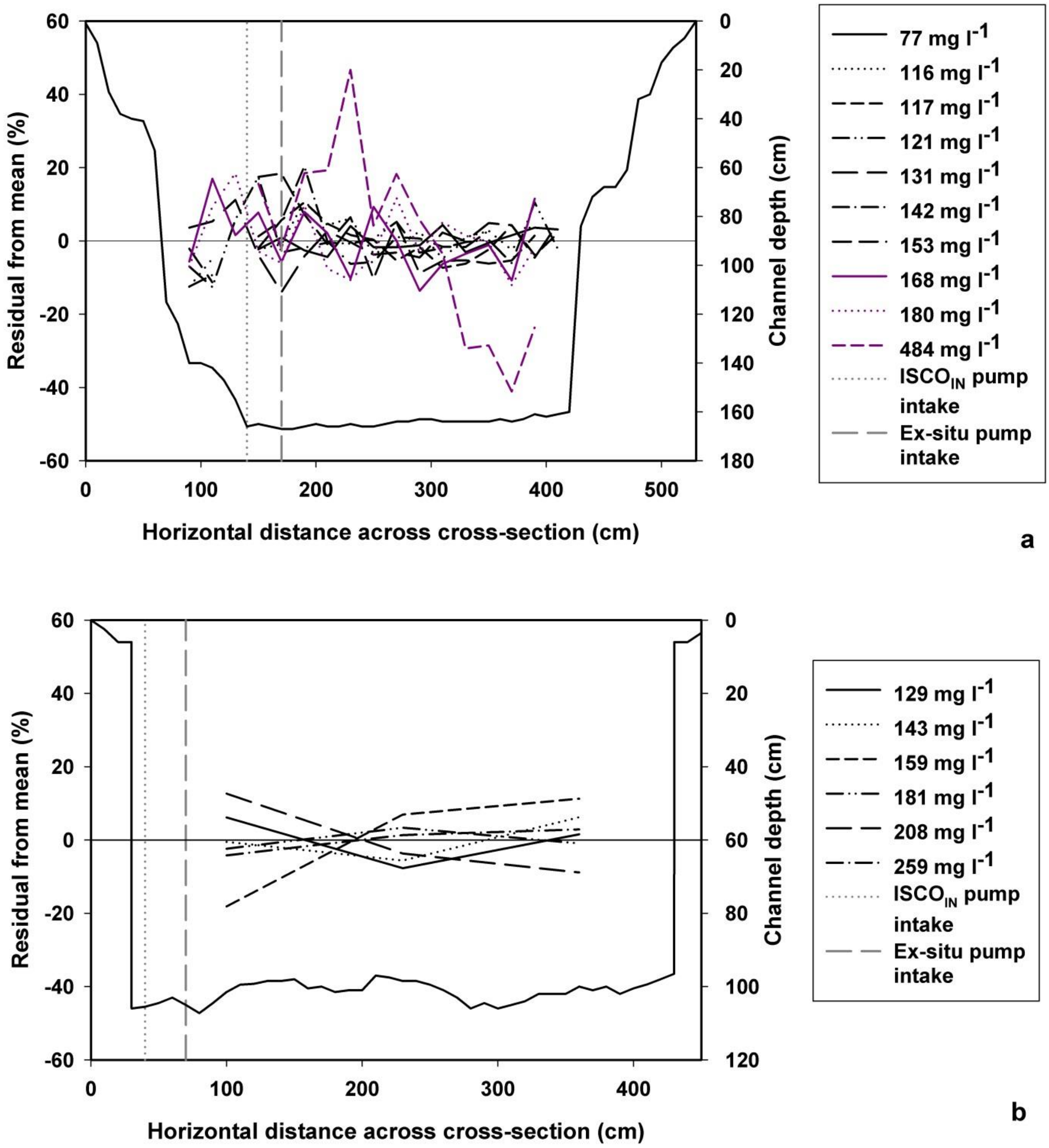

Figure A: Variability of instantaneous depth-integrated SSC measurements across the channel cross section comapred to the mean transect SSC a US DH-48 sediment sampler at a) Grassland B and, b) Arable B.

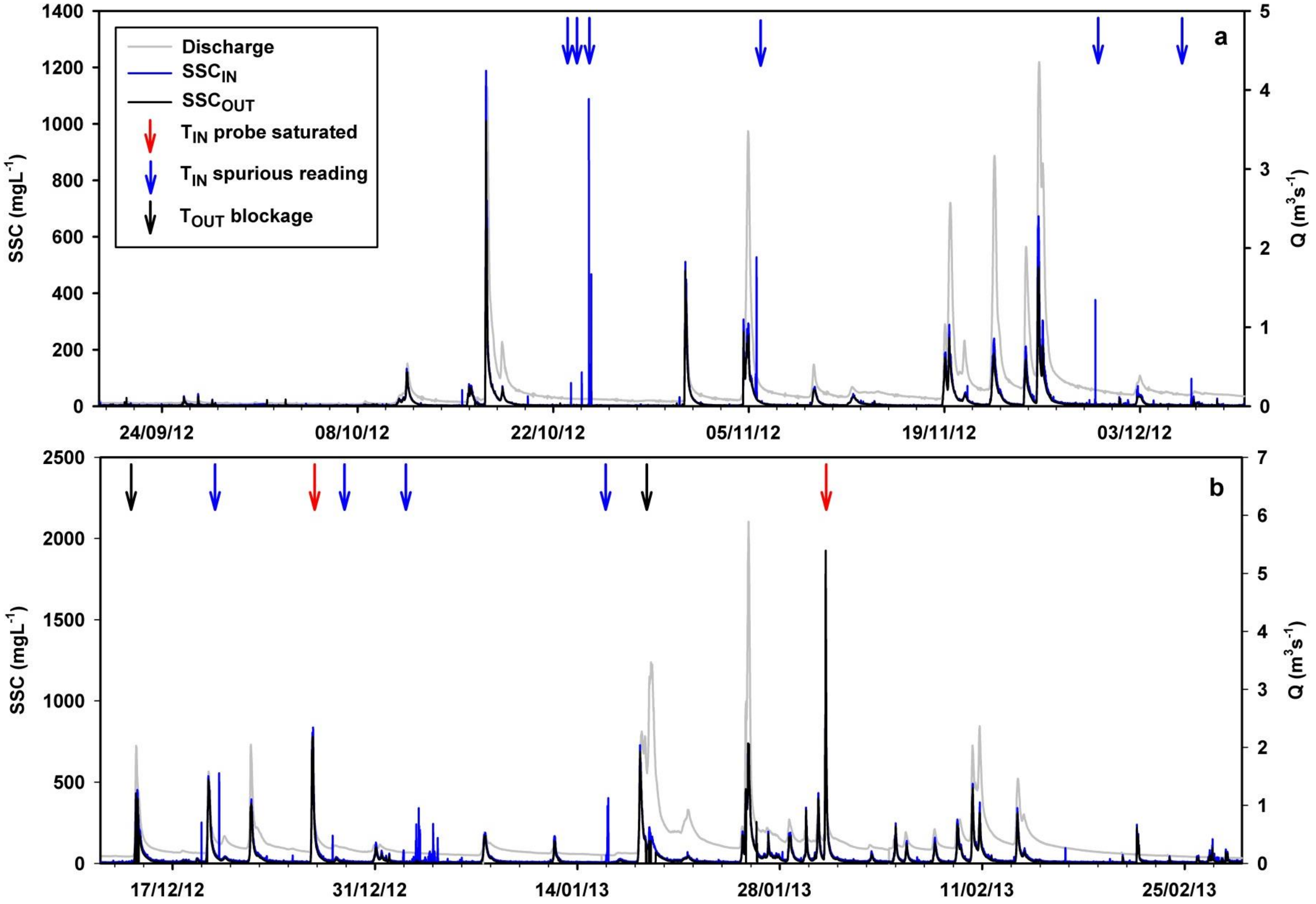

Figure B: Raw turbidity output of T_{IN} and T_{OUT} sensors (converted to SSC) and discharge at a) Grassland B and, b) Arable B. Periods of missing data are annotated by arrows.

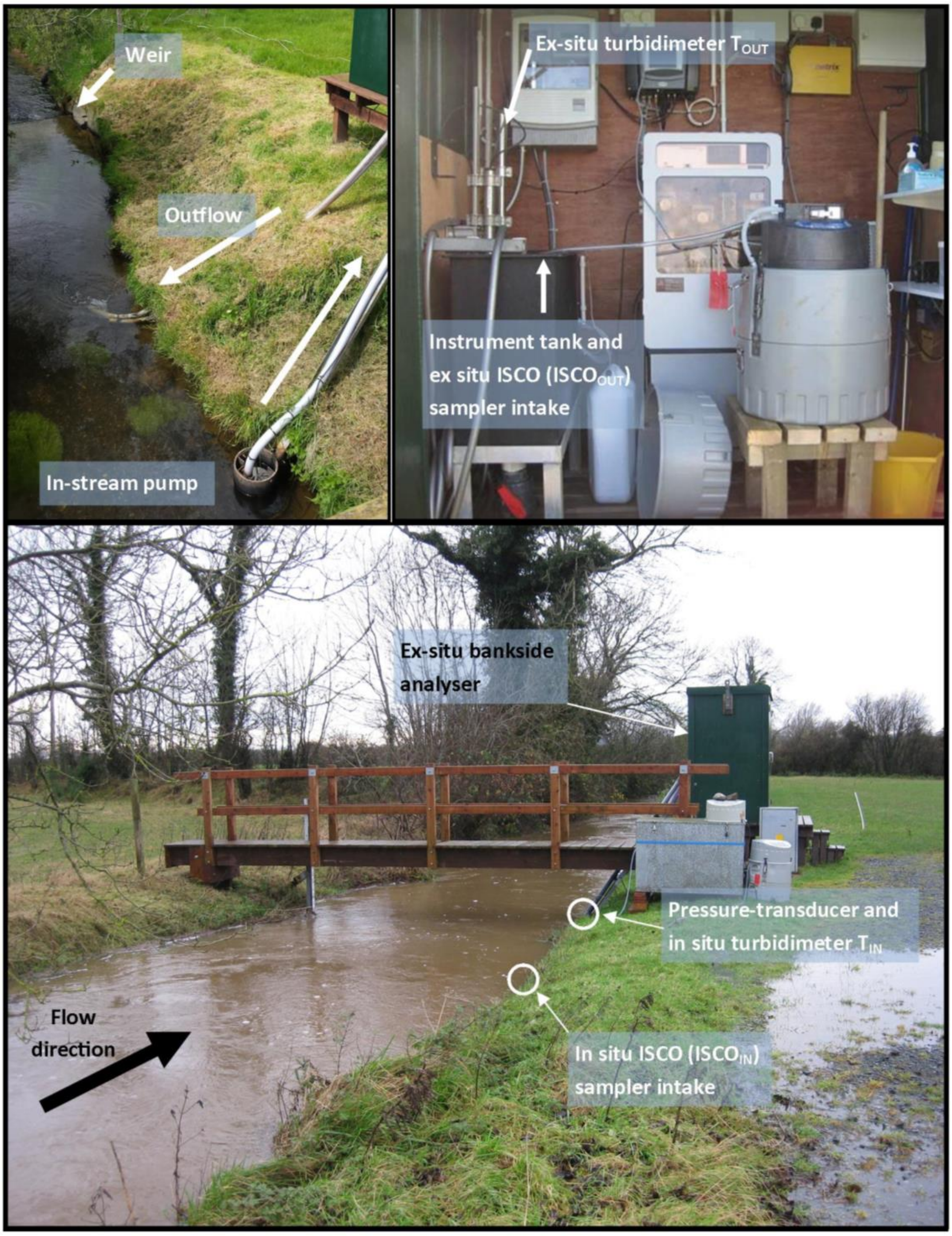

Figure C: Picture of in situ and ex situ suspended sediment and discharge instrumentation at Grassland B.

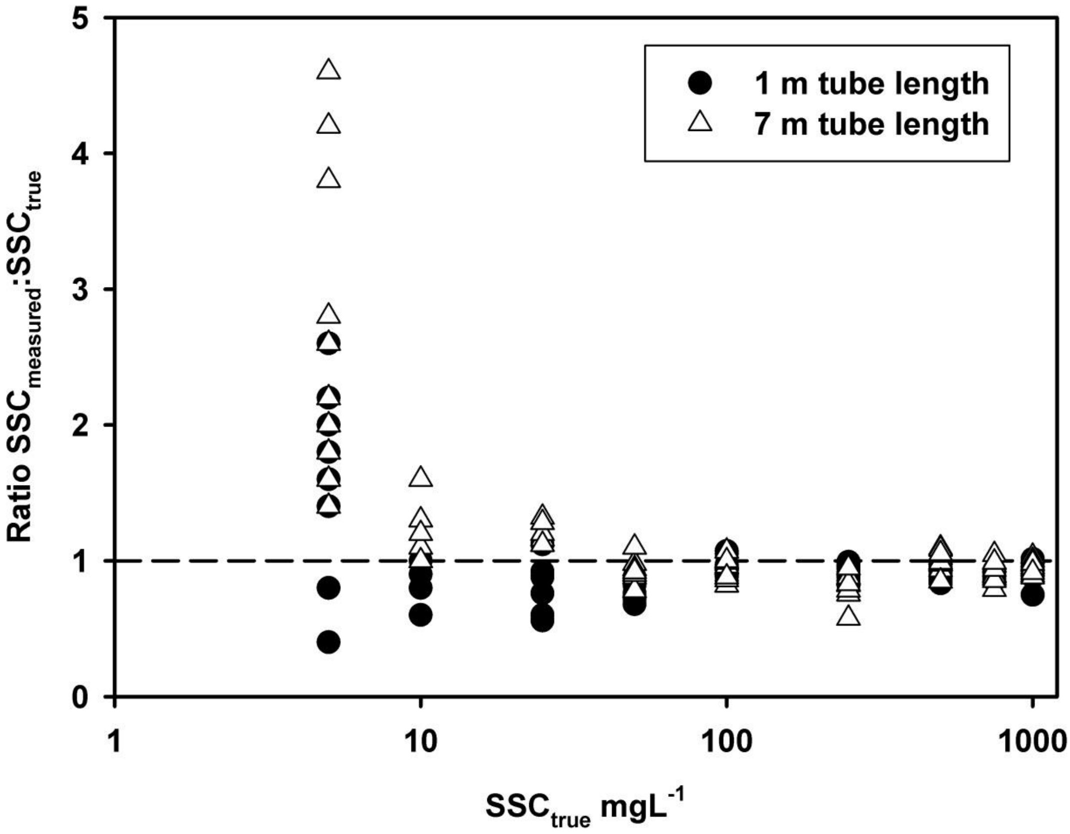

Figure D: SSC of samples collected from known concentration mixtures (SSC_{true})using ISCO water samplers with 1m and 7m tube lengths.

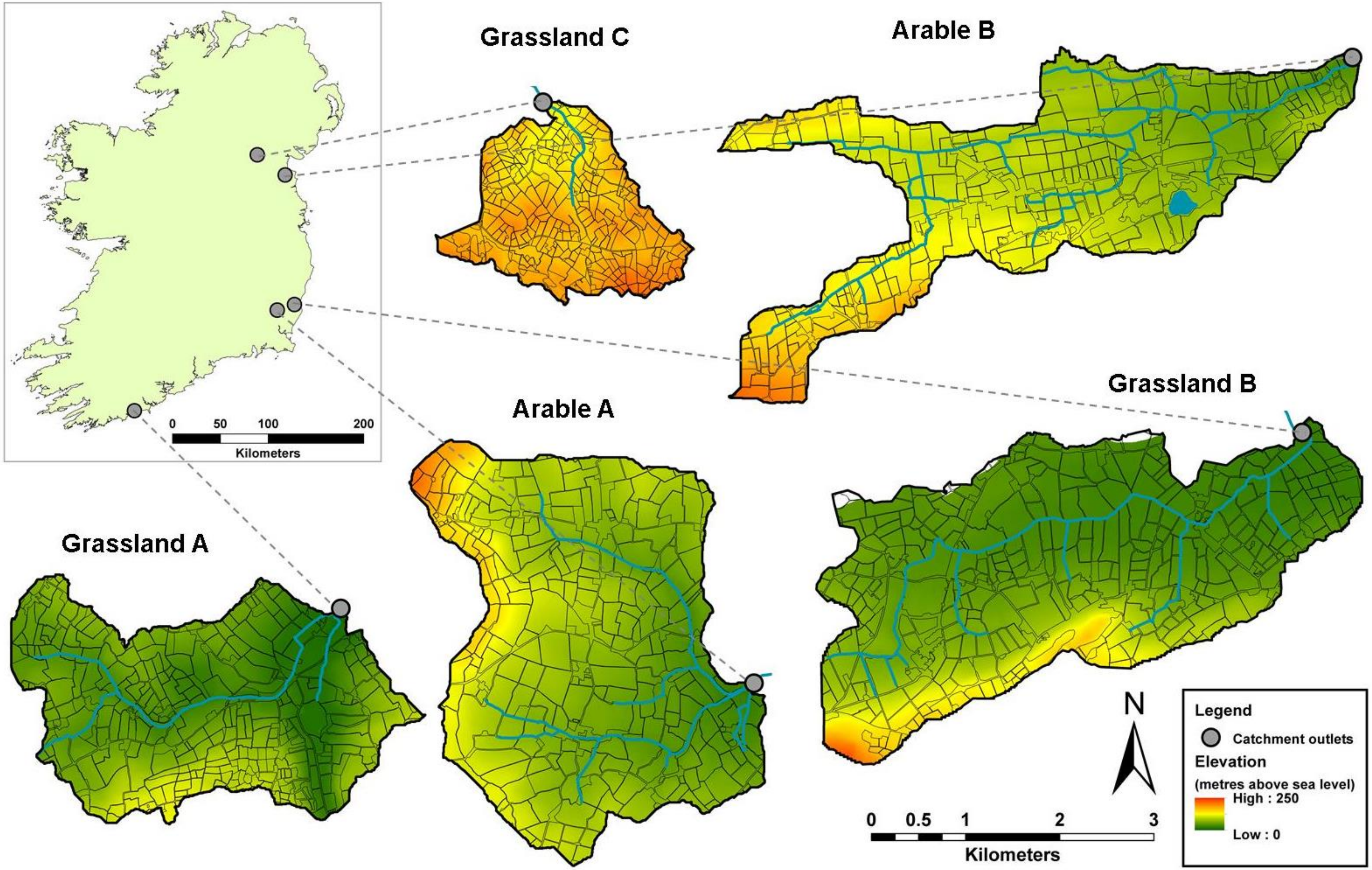

Figure 1. Map of catchment monitoring locations and study catchments with topographic and field size information.

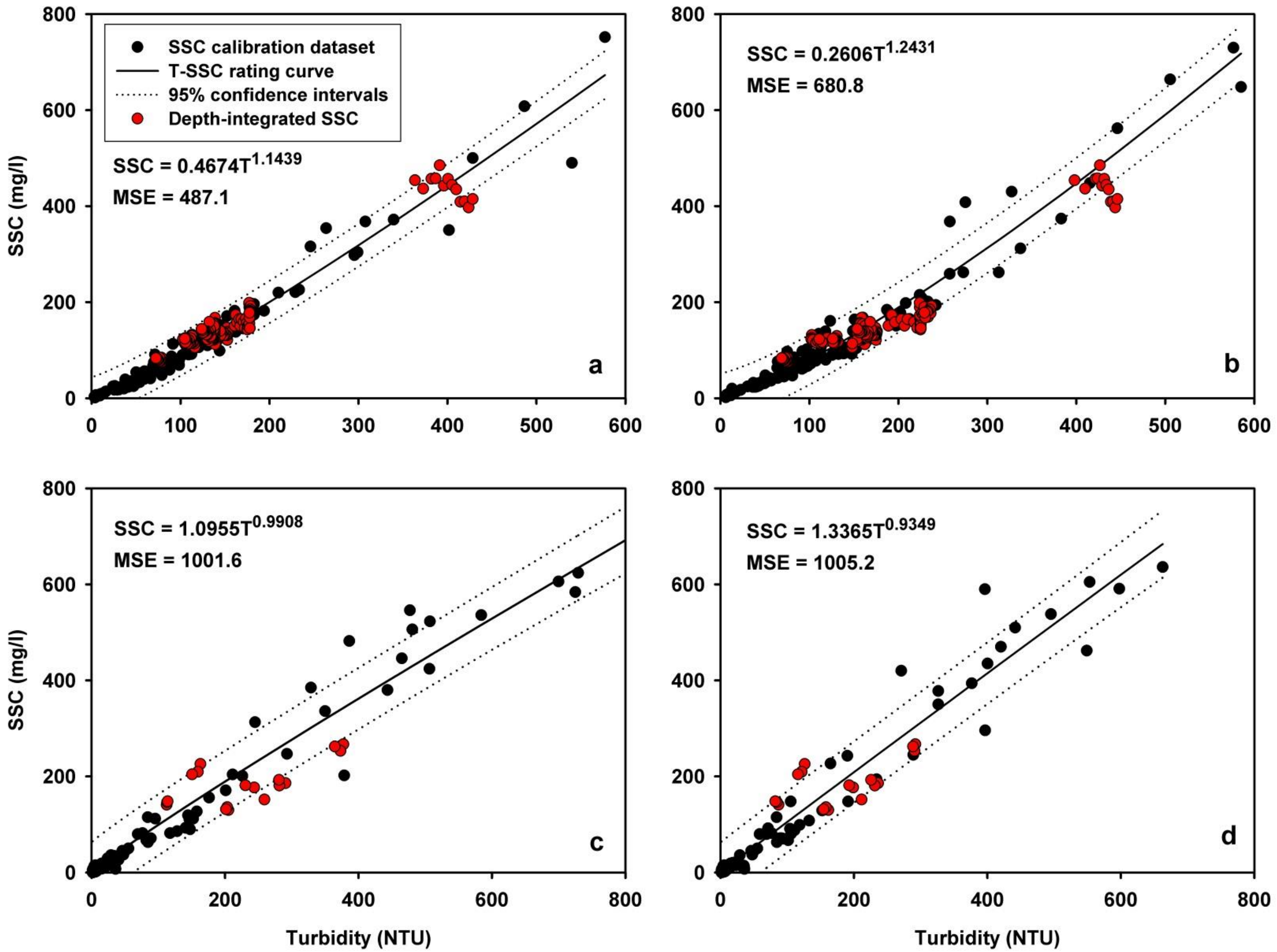

Figure 2. Turbidity-suspended sediment concentration rating curves, confidence intervals, calibration data and cross-section depth-integrated suspended sediment concentration samples for, a) Grassland B T_{OUT}, b) Grassland B T_{IN}, c) Arable B T_{OUT}, d) Arable B T_{IN}.

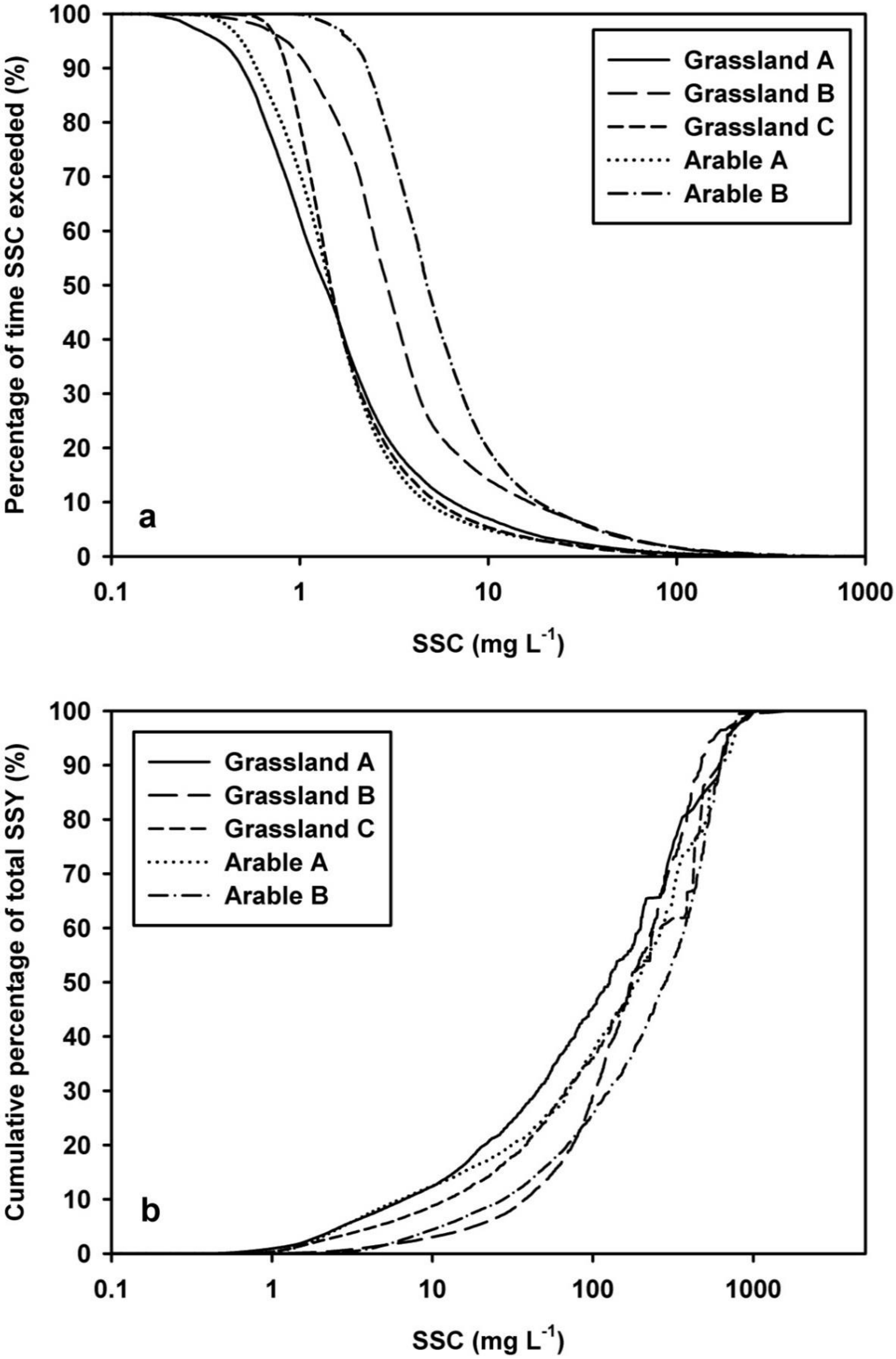

Figure 3. Frequency-duration graphs of, a) suspended sediment concentration exceedance with time and, b) Cumulative percentage of suspended sediment yield with exceedance of suspended sediment concentration.

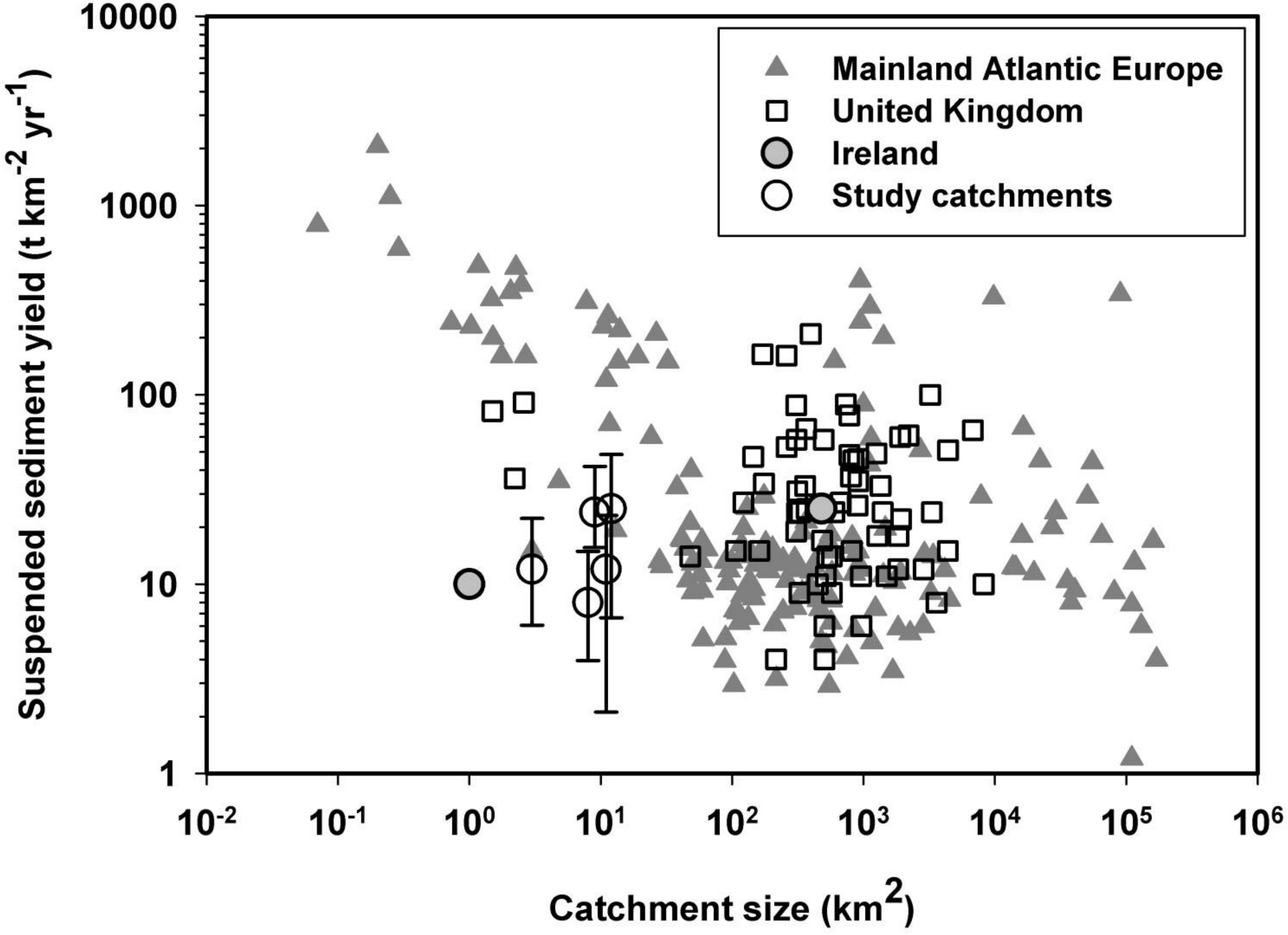

Figure 4. Catchment size and suspended sediment yield of European river catchments, study catchments displayed with inter-annual range. Sources: Foster et al. (1986); Milliman and Syvitski (1992); McManus and Duck (1996); Wass and Leeks (1999); Huang and O'Connell (2000); Verstraeten and Poesen (2001); Jordan et al. (2002); Walling et al. (2002); Harlow et al. (2006); Oeurng et al. (2010); Zabaleta et al. (2007); Gay et al. (2014).

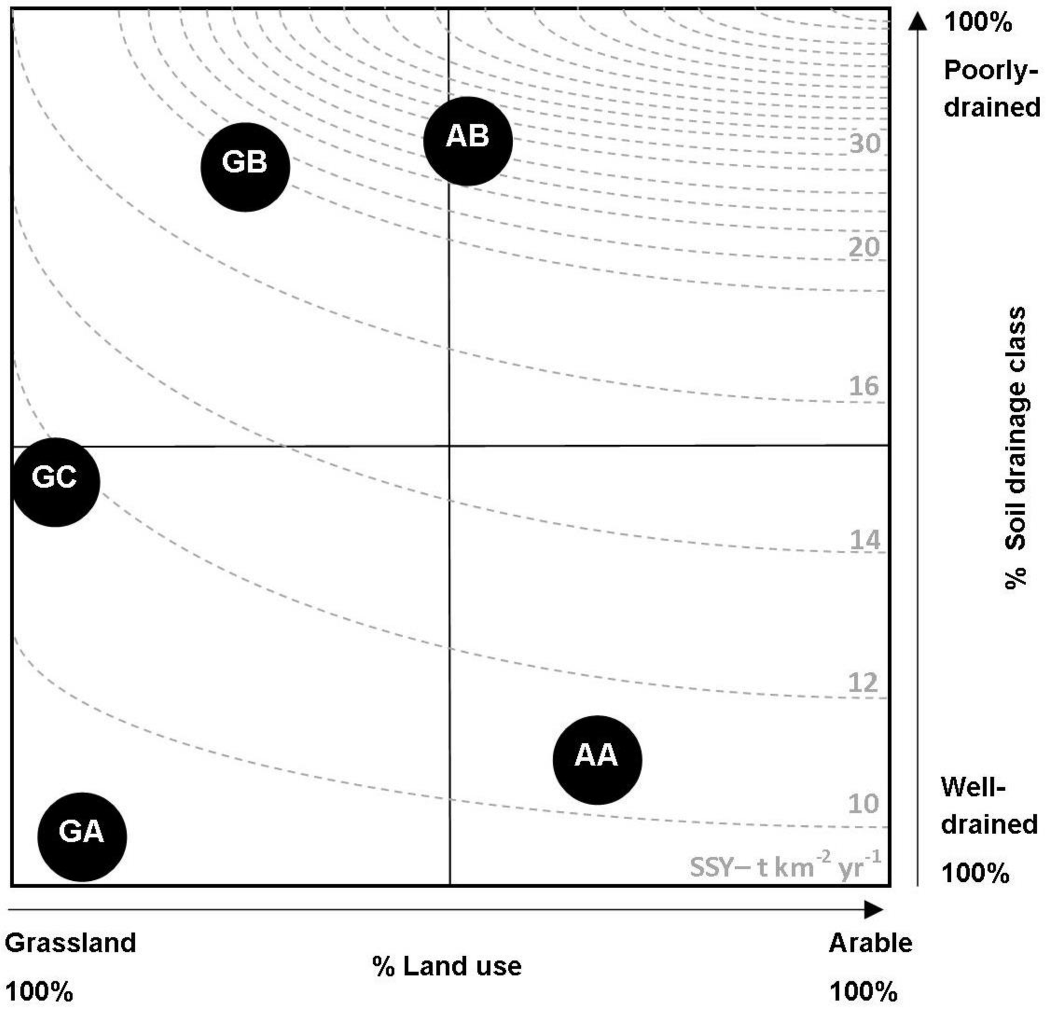

Figure 5. Conceptual diagram of suspended sediment yield as represented by iso-lines according to land use and dominant soil drainage class. Catchment abbreviations: GA- Grassland A, GB- Grassland B, GC- Grassland C, AA- Arable A, AB- Arable B.

Table A: Turbidity- Suspended sediment calibration dataset summary and rating curve equations and fit parameters

Catchment	Data points	Calibrated turbidity range (NTU)	Maximum measured turbidity in NTU (number of data points outside calibrated range)[a]	Calibration equation	MSE
Grassland A	247	0.044-725	1074 (n=7)	$SSC=0.6636T^{1.1045}$	495
Grassland B	443	0.506-577	1179 (n=37)	$SSC=0.5657T^{1.1109}$	580
Grassland C	339	1.170-154	1225 (n=207)	$SSC=0.4341T^{1.2148}$	38
Arable A	231	1.177-767	2730 (n=30)	$SSC=0.4119T^{1.1456}$	891
Arable B	242	0.75-1853	1853 (n=0)	Where $T<432.2$ $SSC=1.1320T$ Where $T>432.2$ $SSC=0.5288+0.6032T$	1335

[a]Number of data points at 10 min resolution

Table 1. Summary of study catchments.

Catchment	Size (km^2)	30-year average rainfall[a] (mm yr^{-1})	Median slope (°)	Dominant soil drainage class/ *flow pathway*	Land-use	Landscape complexity features			
						Field size (ha)	Maximum down-slope length (m)	Hedgerow density (km/km^2)	Ditch density (km/km^2)
Grassland A	7.9	1228	4	Well-drained *Sub-surface*	89% grassland predominantly for dairy cattle; 5% arable	2.00	170	0.061	1.7
Grassland B	11.5	906	3	Poorly-drained *Surface*	77% grassland for dairy cattle, beef cattle and sheep; 12% spring crops 2% winter crops	3.04	189	0.011	5.7[b]
Grassland C	3.3	960	6	Moderately- to poorly- drained *Surface*	94% grassland for beef cattle, dairy cattle and sheep	1.12	114	0.044	2.6
Arable A	11.2	906	3	Well-drained *Sub-surface*	54% arable predominantly spring crops; 39% grassland mainly for beef cattle and sheep	3.32	194	0.011	1.3[b]
Arable B	9.4	758	3	Poorly- drained *Surface*	24% winter crops; 29% grazing for beef cattle and sheep; 19% dairy cattle grazing	2.70	200	0.011	2.3

[a]1981-2010 mean annual rainfall
[b]from Shore et al., (2013)

Table 2. Suspended sediment metrics estimated using in situ and ex situ turbidity based SSC estimation methods.

Catchment	Total load (t)[a]		Mean concentration (mg L^{-1})		Max concentration (mg L^{-1})	
	SSL_{OUT}	SSL_{IN}	SSC_{OUT}	SSC_{IN}	SSC_{OUT}	SSC_{IN}
Grassland B	128±28	154±35	13.7	16.2	1010	1188
Arable B	225±54	248±52	29.1	34.1	2043	823[b]

Note: [a] confidence intervals are the coefficient of variance of the mean prediction, [b] T_{IN} sensor saturated at 1000