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Discussions

Interactive comment on "An index of floodplain surface complexity" *by* M. W. Scown et al.

M. W. Scown et al.

mscown2@myune.edu.au

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Reply by Scown et al. to Janet Hooke's comments

The authors thank Janet Hooke for her comments on the manuscript 'An index of floodplain surface complexity'. The topographic complexity of floodplains has received limited research. This is surprising given that the physical surface of floodplains forms the template upon which biogeochemical processes operate; therefore it is an area of interest for geomorphology, hydrology and ecology. There are a limited number of quantitative methods for measuring the complexity of floodplain surfaces hence the impetus for the research presented in this manuscript. Hooke raises six main points about this manuscript which are addressed below.

1. Lack of humid floodplains in the analysis. The research presented was limited

to those floodplains that had high quality LiDAR data available to the authors. Eight floodplains from different geographic settings were selected and we are confident that they represent a range of floodplain surface conditions. Some of the floodplains used did have a range of morphologies present, like oxbows, flood runners and meander scrolls. The inclusion of humid floodplains in future analyses would be beneficial.

2. Resolution of LiDAR images. The DEMs were available at varying resolutions with the coarsest being a 5 $\times$ 5 m2 grid size. All were subsequently resampled to this resolution to ensure consistency between the eight floodplains. A brief clarification of this will be provided in the revised manuscript.

3. Floodplain delineation. Multiple lines of evidence were used to delineate the floodplain extents. This delineation was based on examination of breaks of slope in the DEM, contours, changes in vegetation from aerial photography, and floodwater extents derived from Landsat TM imagery. A buffer within this manually delineated extent was also removed to ensure nothing other than what was deemed to be part of the floodplain was included. Permanently inundated areas were also removed because attaining accurate subsurface land elevations using LiDAR is difficult. These methods will be briefly described in the revised manuscript and the reader will be referred to Scown et al 2015 Floodplain complexity and surface metrics: Influences of scale and geomorphology, Geomorphology 245 102-116, in which detailed methods are provided.

4. Rationale of the three scales of analysis. The scales used in this manuscript and the importance of scale in measuring floodplain complexity has been the focus of another manuscript (see Scown et al 2015 Measuring floodplain spatial patterns using continuous surface metrics at multiple scales. Geomorphology 245 87-101). We will supply reference to this manuscript in the revision. We will also include a brief discussion of measurement scales relative to floodplain width in the revised manuscript.

5. Limited discussion on the origins of the surface complexity. The primary aim of this manuscript was to construct an index of floodplain complexity that could be used

in conjunction with high resolution LiDAR. The research presented, provides such an index and consists of two main sub-indices – variability in surface geometry and spatial organization, which are two main components of spatial complexity. These two sub-indices are composed of a number of individual metrics. Hence there has been a limited discussion of the geomorphic origins of the surface topography. This is the scope of another manuscript.

6. Overall mechanical and somewhat laborious delivery of the results. The results section will be revised to reduce its length and deliver the key messages more succinctly in the text.

Reply by Scown et al. to anonymous reviewer's comments

The authors thank this reviewer for the constructive comments provided on the manuscript. We agree that the focus of the manuscript covers an important topic and does use state-of-the-art techniques and methods to assess this complexity. The reviewer raises several points that require clarification.

1. The provision of a general framework and the need to answer complexity for what? The primary focus of the research presented was to provide an index of floodplain complexity and not to provide a Framework for the Complexity of Floodplains. This is the subject of Scown et al., in press – (Scown et al in press Measuring spatial patterns in floodplains: A step towards understanding the complexity of floodplain ecosystems. In Gilvear, Thoms, Wood and Greenwood (Eds) River Research and Management for the 21Century. Wiley.) and this reference is included in the manuscript. Complexity for what? We have clearly stated that this research is aimed at presenting an index to measure the physical complexity of floodplain surfaces. What this physical complexity means for biogeochemical process is the subject of ongoing research.

2. Methods and clarification of what was done. A number of points are made by this reviewer.

a. More information on the individual floodplains will be provided in the revised manuscript.

b. The method of constructing each DEM is provided in Scown et al. 2015, Geomorphology, and reference will be made to this publication in the revised manuscript. Basically, the Digital Elevation Models of the eight of floodplains selected were constructed from high resolution LiDAR data. Each DEM was detrended by generalizing the 1-m valley contours across each floodplain and creating a trend surfaceâĂŤbased on the downstream slope. This was done in order to remove the overall downstream slope. This trend surface was then subtracted from the original DEM to produce a detrended DEM that contained heights above a zero datum, which represented the lowest point relative to the overall downstream slope in the floodplain. Finally, the detrended DEMs were all resampled to a 5 $\times$ 5 m2 grid size using the cubic method in ArcGIS 10.2 to ensure consistent resolution among the eight floodplains.

c. The use of multiple regression to quantify the relationship between environmental variables and floodplain complexity. A multi-variate index was used in these analyses, which we considered appropriate in order to answer the questions set in this manuscript. Multiple regressions were considered but they were determined not to be appropriate because of the data set we had assembled (n = 8 floodplains). As such data become widely available over more floodplains and are analysed, further investigation of associations using multiple regression would be beneficial.

3. Scale/resolution of the data used and size of floodplain. The scales used in this manuscript and the importance of scale in measuring floodplain complexity has been the focus of another manuscript that will be referred to in the revision. Three window sizes were chosen for this research and their scale extends over 3 orders of magnitude (101-103 m). This range of scales is capable of capturing true effects of floodplain width given that the floodplains ranged in width over only 2 orders of magnitude (103-104 m) this is noted in other published work by the authors. This is an important point raised by both reviewers and we will discuss this in the revised manuscript. However, conducting

this entire study again with different scales of investigation seems unnecessary given that it provides novel and useful information and approaches to measuring floodplain surfaces in its current form.

4. Overstating of floodplain width as the key “top-down” controlling factor of floodplain complexity. The reviewer has raised a number of points in this section of their feedback.

a. Floodplain style – most geomorphologists are in agreement that floodplain style or type is determined by its valley setting, sediment character and availability, and hydrology (e.g. Nanson and Croke, 1992, Geomorphology). Thus, we have accounted for most of the factors influencing floodplain style in this study.

b. Human impacts – the floodplains selected were largely natural floodplains and all have experienced very little human impact in terms of their surface topography. The greatest human impacts to these floodplains have been through alterations to their natural flow regimes, which may provide some explanation as to why contemporary hydrological parameters were not associated with surface complexity.

c. Vegetation effects and hydrogeomorphic processes – we absolutely agree with this reviewer that these are important contributors to floodplain surface complexity but we argue that they are “bottom-up” influences in the sense of a river hierarchy (Thorp et al. 2008, The River Ecosystem Synthesis). Thus, these are factors beyond the scope of the present study, which examined only “top-down” effects. We will make additional mention of the importance of “bottom-up” effects in the revised manuscript and discuss the potential for future research along this avenue.

5. Complexity indicators put forward in this manuscript should be compared to well-established landscape indicators (e.g. patch size, diversity, contrast, connectivity, etc). We argue that landscape indicators such as patch size, diversity etc are inappropriate for measuring floodplain surfaces. Both have received detailed criticism in the literature, especially in defining what is a patch and how patch-based approaches lose much information in describing the spatial organization of surfaces. Comparisons of

patch and surface based landscape indicators have been carried out by McGarigal et al. 2009, Landscape Ecology. They found a high degree of redundancy in patch metrics and discussed many advantages of a surface based approach. We will include a brief discussion contrasting a surface based approach to a patch based approach in floodplains in the revised manuscript.

6. To which extent does the present approach differ from a meta-ecosystem approach? E.g. the meta-ecosystem concept focuses on habitat complexity by considering the composition, configuration, and connectivity of ecosystem entities. The meta-ecosystem approach (sensu Loreau et al. 2003, Ecology Letters) provides a framework for examining connections, interactions, and flows among component ecosystems within a meta-ecosystem. This type of framework has been specifically applied to ecosystem complexity by Cadenasso et al. 2006, Ecological Complexity, who described three dimensions of ecosystem complexity as heterogeneity, connectivity, and contingency. The present study provides an index of spatial complexity composed of two sub-indices, which indicate variability (heterogeneity) and spatial organization (which influences connectivity), for floodplain surfaces. Thus, the present study provides a quantitative index of the two spatial components of ecosystem complexity within a meta-ecosystem framework described by Cadenasso et al, which to the best of our knowledge has not previously been achieved in floodplains. This manuscript compliments these broader scientific ideas, but differs greatly from the established literature in that it provides quantitative measure of the spatial component. The temporal component (contingency) is beyond the scope of this study. We agree with this reviewer that by discussing how the present study relates to these frameworks, it will sit better within a landscape context. This will be included in the revised manuscript and we thank the reviewer for this input.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 4507, 2015.