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Interactive Comment

Interactive comment on "Quantifying river form variations in the Mississippi Basin using remotely sensed imagery" *by* Z. F. Miller et al.

Anonymous Referee #3

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Colleague Review: Z.F. Miller, T. M. Pavelsky, and G.H. Allen, "Quantifying river form variations in the Mississippi Basin using remotely sensed imagery". Date: July 19, 2014.

General Comments and Suggestions: Following is a general summary of the points that I address in my comments. General Summary: The paper is a valuable contribution to data needs and implications for the classic concept of hydraulic geometry. The paper presents the concepts and data in the context of river channel form and considers the down-the-channel hydraulic geometry of the channel cross-section, and documents width variation within channel networks using remotely sensed imagery.

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Interactive Discussion

Discussion Paper

The USGS NLCD (based on Landsat) is used to map river widths at each pixel along the centerline of the river in the image. Because the NLCD is based on Landsat, the image pixel resolution is 30m. Thus, there is a river width calculated every 30m down the river channel. Width measurement errors are on the order of 32m (approximately one pixel), and the nominal river width that can be observed with meaningful accuracy is considered to be on the order of 100m. The method assumes that the mapped river widths represent, approximately, a mean flow condition. Mean discharge and depth were estimated for each width measurement to develop a spatially dense data set of width, discharge and depth for the channel network. The discharge was estimated by developing watershed area-mean discharge relations for USGS gaging stations with > 10 years of record and then computing the mean discharge for all points along the river network within each watershed. The mean depth was estimated from gage measurement data using a depth-discharge relation for each gage, a general relation from Moody and Troutman, and a multi-variable relation between depth-discharge and width. General hydraulic geometry relations were developed from the data for the entire study area, and for smaller regions within the study area. It was found that there is substantial variation in the hydraulic geometry relations for different basins, and that multivariate relations that include discharge and width were better at predicting cross-section depth compared to using discharge alone.

General Comments: 1) The paper indicates that it considers channel form, but in fact it addresses only the cross-section geometry. Channel form also includes the downstream dimension, reflected by channel slope and by planform shape (e.g. meander length). Bjerklie (2007) (Bjerklie, D.M. 2007. "Estimating the bankfull velocity and discharge for rivers using remotely sensed river morphology information", Journal of Hydrology 341: 144-155), Williams (1986)(Garnett, W.P., 1986. River Meanders and Channel Size, Journal of Hydrology, 88 147-164), Jansen and others (1979)(Jansen, P., van Bendegom, L., van den Berg, J., de Vries, M., Zanen, A. 1979. Principles of River Engineering, Pitman, p. 509) have shown that the meander length (and thus channel planform features in general) are correlated to channel cross-section depth and velocity (and thus flow resistance). Similarly, the channel slope is also a key variable in the relation between cross-section geometry and discharge. Therefore these additional channel form variables can provide important predictors for channel geometry-discharge relations. It is suggested that, in keeping with the stated goal to consider channel form and use remote sensing as a primary data source, channel slope and planform be discussed in the introduction and in the discussion/conclusion section as variables that could/should be included to develop more robust, and more reach specific channel geometry relations. It is recognized that channel slope and planform shape data sets are not readily available, however remote sensing offers the opportunity for these to be measured throughout a channel network.

2) It is important to understand that the relations developed here are assumed to be associated with a particular flow event – the mean flow – but the width measured is not necessarily associated with the mean flow, and therefore contributes to some of the variability in the width distribution particularly as it relates to the mean discharge. Additionally, the mean discharge itself is not necessarily comparable between aging stations due to differing lengths of record and time periods. These issues introduce unknown errors that are not easily addressed. However, in the discussion the possible implications of these issues could be pointed out and the importance of statistical approaches to analyzing and interpreting the data discussed.

3) The resolution of the pixels used to estimate the widths will have a greater effect on accuracy the smaller the river becomes. River size has a lot to do with the error and, thus it might be helpful to develop the hydraulic geometry relations for different size classes of rivers and see if there is a large difference.

4) There is no discussion of whether a minimum size of watershed and or discharge was used to reduce the number of discharge relations developed. This should be included in section 3.4

5) Additional data and study of regional relations between hydraulic variables in

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a cross-section have been published by the USGS (see Osterkamp, W. R.; Hedman, E. R., 1982, Perennial-streamflow characteristics related to channel geometry and sediment in Missouri River basin, USGS Professional Paper: 1242 (http://pubs.er.usgs.gov/publication/pp1242)). These previous studies can be referenced to provide additional comparison and validation.

6) Bjerklie and others, 2003, (Bjerklie, D.M., S. Lawrence Dingman, Charles J. Vorosmarty, Carl H. Bolster and Russell G. Congalton, 2003. "Evaluating the potential for measuring river discharge from space", Journal of Hydrology, vol. 278 no. 1-4 pp. 17-38) showed the importance of multivariate equations and inclusion of channel slope to improve the predictive qualities of general hydraulic relations for rivers. This is expected, as the more pertinent information is brought to bear to the prediction, the prediction will be better. The implication of multi-variate relations is that they are no longer directly derived from continuity and dimensional analysis. To accommodate multi-variate relations, perhaps it can be suggested that the original definition of hydraulic geometry be expanded to include flow resistance as indicated by channel planform and slope.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 3599, 2014.