Drones for River Habitat Assessment?

A Report from the International Symposium on Ecohydraulics

7-12 February 2016, Melbourne, Australia

Every 2 years, the International Symposium on Ecohydraulics (ISE) provides an opportunity for the exchange of knowledge, sharing of practical experiences and collaboration between academics and practitioners working across the many disciplines of ecohydraulics, including aquatic ecology, water engineering, hydraulics, fluvial geomorphology and biogeochemistry. The interconnectedness of these disciplines within ecohydraulics is fundamental in addressing many of the present challenges we face in terms of river and water resource management.

Flying the Draganflyer X6 rotary-winged drone at Coledale Beck, Cumbria in July 2013

As a remote sensing scientist, the ISE held in Melbourne this year was my first proper venture into the world of ecohydraulics. Last year I completed my PhD on the use of drones for quantifying physical river habitat parameters and am now working as a post-doc at the University of Worcester. My research focusses on the testing and development of drones as a method or tool for fluvial surveying purposes, including detailed assessments of the accuracy and reliability of this tool. The good news is that we have been able to demonstrate some promising outputs, including the quantification of physical habitat variables such as water depth, topography and grain size (e.g. Woodget et al., 2015, 2016). However, as the hype of drone-based research continues, we (as remote sensing specialists) may run the risk of becoming so absorbed by the technological developments that we fail to evaluate fully and realistically their application to real-world scenarios. In my view, without an application-driven focus we might just as well be playing with expensive toys. So, in light of this, I set out to the latest Ecohydraulics meeting with two main aims; (1) to explore whether the drone-based research I have completed so far would be of value to those who actively monitor and manage river systems on a routine basis, and; (2) to establish the on-going needs of this community which must to be met in order enable the progression of drone-based surveying from proof-of-concept to a realistic tool for operational use.

The research I presented at ISE was entitled 'Quantifying fluvial substrate size using hyperspatial resolution UAS imagery and SfM-photogrammetry'[1] (Woodget et al., 2016). Within this paper, we

[1] UAS stands for 'unmanned aerial system', a term frequently used to describe drones within the academic arena. SfM stands for 'structure-from-motion', an adapted method of digital photogrammetry which enables the generation of

demonstrate that it is possible to establish a calibration relationship between grain size and point cloud roughness (an output variable from the UAS-SfM method) for a series of trial plots located at our field site in the English Lake District. This calibration then permits the prediction of grain sizes over an entire study area in a way which is rapid, flexible, spatially continuous, spatially explicit, high resolution and high accuracy. As such, this approach provides significant advantages over qualitative grain size classification schemes and is especially well suited to surveying smaller sites (patch to reach scale) where quantification of the detailed heterogeneity of the riverscape is required. However, this method remains in its infancy and further refinement is necessary to improve the precision of grain size estimates, to better account for the effects of clast packing and imbrication, and to extend the application to submerged parts of the river system.

Ecohydraulics Conference Venue – the Melbourne Cricket Ground

Much discussion of the technical details of our approach followed, which was constructive and will prove valuable in overcoming some of the method's current limitations. However, the most interesting and thought-provoking discussions were related to my initial reasons for attending this Symposium and I would like to share just one example with you. This centres on conversations I had with ecologist John Nestler (keynote speaker) and others, on the very concept of river habitat, how we map, categorise, measure and define it and what a drone-based approach may have to offer.

Numerous methods of 'knowing' the physical river habitat exist. They help to inform our understanding of the what, where, how and why of fluvial dynamics, which in turn influences the prevailing paradigms of the discipline. Most of our methods of 'knowing' use qualitative classification schemes to divide up the system based on visual assessments (e.g. surface flow types) and/or quantitative point or cross sectional measurements of specific hydraulic and geomorphic parameters (e.g. depth, velocity, grain size). Within such approaches, we make decisions concerning which classification scheme or measurement method to use, the scale, coverage and frequency of sampling, and in some instances, the method of extrapolation. Our decisions are often led by the nature of the application, existing practices or protocols within particular geographic regions, and the availability of time, funds and resources. As a result, the habitat classification methods we use as a community can be highly subjective, scale-dependent, non-transferable, inconsistent and may be based on inference or extrapolation. The direct antithesis of this is an objective, rapid, spatially continuous, inexpensive method of quantifying physical habitat variables over a range of spatial and temporal scales, with high precision and accuracy. The luxury of such a method has been previously

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orthophoto mosaics, point clouds and digital elevation models (DEMs) from a series of overlapping photographs, regardless of variations in image scale, illumination and orientation.

unattainable within ecohydraulics. As our research and that of others demonstrates however, significant technological advances in UAS platforms and associated digital photogrammetric processing techniques (e.g. SfM) over recent years are beginning to change this, and provide a new method of surveying physical habitat conditions (e.g. Flener et al., 2013, Tamminga et al., 2015). As a result, and following my conversations at the Ecohydraulics Symposium, it seems that there is an appetite to begin moving away from broad classifications of river habitat and towards detailed continuums of quantitative data. Clearly such a shift needs to be accompanied by continued refinement of this drone-based method, systematic experimentation in a range of contrasting fluvial environments and an associated provision of appropriate training and support for practitioners and researchers alike. In theory, however, this novel approach has the potential to provide new opportunities for 'knowing' the physical river habitat as a continuum, especially those smaller and more marginal features which often become 'invisible' within broad-scale classifications. Examining this detailed heterogeneity may permit new insights into the ecological importance of physical habitat and its spatial and temporal significance. It is certainly an exciting time to be involved in drone-based fluvial research and I look forward to both the challenges and benefits these new methods may bring to our discipline in future.

I would like to thank the BHS for their financial support for my attendance at the ISE in Melbourne, and would welcome any comments or questions from the BHS community on the themes discussed within this report.

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Attend our forthcoming conference at the University of Worcester (UK), 28-29th June 2016
www.worcester.ac.uk/discover/uav-conference.html

References

Flener, C., et al., (2013) Seamless mapping of river channels at high resolution using mobile LiDAR and UAV-photography. *Remote Sensing* 5: 6382-6407

Tamminga, A., et al., (2015) Hyperspatial remote sensing of channel reach morphology and hydraulic fish habitat using an unmanned aerial vehicle (UAV): A first assessment in the context of river research and management. *River Research and Applications* 31 (3): 379-391

Woodget, A.S., et al., (2015) Quantifying submerged fluvial topography using hyperspatial resolution UAS imagery and structure from motion photogrammetry. *Earth Surface Processes and Landforms* 40 (1): 47-64.

Woodget, A.S. et al., (2016) Quantifying fluvial substrate size using hyperspatial resolution UAS imagery and SfM-photogrammetry. *Extended Abstract, 11th International Symposium on Ecohydraulics, Melbourne, Australia, 7-12 February*