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Exploring the accuracy of image velocimetry techniques during low river flows.

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Remote sensing for the acquisition of river surface flow velocity has received growing attention recently due to the need for providing flow data in situations when using traditional techniques is impossible, impractical or unsafe i.e. during a flood. Image-velocimetry techniques have become increasingly more accurate as imaging technology improves and better processing algorithms are developed. To date, research into Image-based velocimetry has predominantly focussed upon high flow conditions, therefore the knowledge regarding the boundaries of image-velocimetry during the lower flow range is limited.

Image-velocimetry techniques such as Large-Scale Particle Image Velocimetry (LSPIV) and Space Time Image Velocimetry (STIV) have proved extremely useful and accurate methods for measuring surface velocity and hence river discharge during flood conditions. However, use at lower flows may also provide rapid, non-intrusive remote sensing of discharge and flow velocity measurement for calibrating 2D hydraulic models or for hydroecological / habitat assessment. Therefore, this study aims to consider the applicability of image-velocimetry techniques, specifically LSPIV and STIV, for evaluating the surface flow velocity of different channel geomorphic units (CGUs) during low flow conditions.

This study was carried out on the River Arrow, Warwickshire, UK. Six geomorphic units were chosen: two pools, two glides and two riffles. Each surveyed CGU were of similar size, ranging between 5-8m wide, and approximately 10m in length. At each CGU, oblique imagery was captured from both sides of the bank using GoPro cameras mounted on ~4 m high telescopic poles. As pole mounted cameras were positioned on either side of the channel, at different locations (CGUs) along the reach, all cameras have different orientations to the sun (east, west, north or south facing). Aerial imagery was captured using the DJI Phantom 4PRO UAV with standard fitted camera at a height of approximately 15m above the channel level. All aerial imagery was captured at approximately 90°(nadir), with the UAV positioned over the centre of the river channel. For each CGU, two videos per camera platform were collected: seeded with artificially added seeding material (ecofoam cornstarch packing chips) and unseeded. Videos were recorded at a resolution of 1080p and at 30 frames per second. Ground control points were located along the reach and surveyed using a real-time kinematic GPS to enable the subsequent orthorectification of the video imagery. Surface flow velocity measurements for validation of the image velocimetry estimates were also collected at five cross sections within each CGU using a Valeport electromagnetic current meter.

Surface flow velocity estimations were calculated using both Fudaa-LSPIV (Le Coz et al. (2010)) and Kobe-University STIV (Fujita et al. (2017)). The results presented compare the accuracy of assessing surface flow velocity estimation during low flow conditions depending on i) the type and location of the platform used (UAV or pole mounted camera (east, west, north or south facing)), ii) the type of channel geomorphic unit, iii) the image-velocimetry analysis technique used (LSPIV and STIV), and iv) the presence or absence of seeding.