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Estimating flood discharge using witness movies in post-flood hydrological surveys

Jérôme Le Coz (1), Alexandre Hauet (2), Raphaël Le Boursicaud (1), Lionel Pénard (1), Laurent Bonnifait (3), Guillaume Dramais (1), Fabien Thollet (1), and Isabelle Braud (1)

(1) UR HHLY, Irstea, Lyon, France (jerome.lecoz@irstea.fr), (2) EDF-DTG, Grenoble, France (alexandre.hauet@edf.fr), (3) CEREMA, Trappes, France (laurent.bonnifait@cerema.fr)

The estimation of streamflow rates based on post-flood surveys is of paramount importance for the investigation of extreme hydrological events. Major uncertainties usually arise from the absence of information on the flow velocities and from the limited spatio-temporal resolution of such surveys. Nowadays, after each flood occuring in populated areas home movies taken from bridges, river banks or even drones are shared by witnesses through Internet platforms like YouTube. Provided that some topography data and additional information are collected, image-based velocimetry techniques can be applied to some of these movie materials, in order to estimate flood discharges.

As a contribution to recent post-flood surveys conducted in France, we developed and applied a method for estimating velocities and discharges based on the Large Scale Particle Image Velocimetry (LSPIV) technique. Since the seminal work of Fujita et al. (1998), LSPIV applications to river flows were reported by a number of authors and LSPIV can now be considered a mature technique. However, its application to non-professional movies taken by flood witnesses remains challenging and required some practical developments. The different steps to apply LSPIV analysis to a flood home movie are as follows: (i) select a video of interest; (ii) contact the author for agreement and extra information; (iii) conduct a field topography campaign to georeference Ground Control Points (GCPs), water level and cross-sectional profiles; (iv) preprocess the video before LSPIV analysis: correct lens distortion, align the images, etc.; (v) orthorectify the images to correct perspective effects and know the physical size of pixels; (vi) proceed with the LSPIV analysis to compute the surface velocity field; and (vii) compute discharge according to a user-defined velocity coefficient.

Two case studies in French mountainous rivers during extreme floods are presented. The movies were collected on YouTube and field topography surveys were achieved. Identifying fixed GCPs is more difficult in rural environments than in urban areas. Image processing was performed using free software only, especially Fudaa-LSPIV (Le Coz et al., 2014) was used for steps (v), (vi), and (vii). The results illustrate the typical issues and advantages of flood home movies taken by witnesses for improving post-flood discharge estimation. In spite of the non-ideal conditions related to such movies, the LSPIV technique was successfully applied. Corrections for lens distortion and limited camera movements (shake) are not difficult to achieve. Locating precisely the video viewpoint is often easy whereas precise timing may be not, especially when the author cannot be contacted or when the camera clock is false. Based on sensitivity analysis, the determination of the water level appears to be the main source of uncertainty in the results. Nevertheless, the information content of the results remains highly valuable for post-flood studies, in particular for improving the high-flow extrapolation of hydrometric rating curves.

This kind of application opens interesting avenues for participative research in flood hydrology, as well as the study of other extreme geophysical events. Typically, as part of the FloodScale ANR research project (2012-2015), specific communication actions have been focused on the determination of flood discharges within the Ardèche river catchement (France) using home movies shared by observers and volunteers. Safety instructions and a simplified field procedure were shared through local media and were made available in French and English on the project website. This way, simple flood observers or even some enthusiastic flood chasers can contribute to participative hydrological science in the same way the so-called storm chasers have significantly contributed to meteorological science since the Tornado Intercept Project (1972).

Website : http://floodscale.irstea.fr/donnees-en/videos-amateurs-de-rivieres-en-crue/

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