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UAVs in flood disaster response: a case study from Cumbria

The use of Unmanned Aerial Vehicles (UAVs) to survey the aftermath of natural disasters is an emerging field of research. Paul Drury of flood risk specialists, Ambiental, discusses how the technology was used in response to the recent flooding in Northern England

When record-breaking rainfall from storm Desmond caused widespread flooding across Cumbria in early December 2015 it was a busy time to be working for a flood modelling and risk analysis consultancy. The first priority was to check just how accurate Ambiental's flood models had been in predicting the event.

Flood modelling is a process that simulates the flow of water across a digital terrain surface. The flood maps produced had identified risk at the flood-affected locations, but getting a full and accurately-validated picture of exactly where the flood waters reached, and to what extent, was hard to come by. Apart from piecing together evidence gained from media reports, there is often a lack of such data being captured during and in the immediate aftermath of peak flood events. Such data would also prove highly valuable to emergency responders and to insurance companies looking to assess their losses.

Consortium approach

It was therefore most fortunate timing that, in the week prior to these devastating floods, a consortium had been formed through a grant awarded by the Natural Environment Research Council. Working with academic partners from Cranfield, Loughborough, Leicester and Imperial College Universities, a project was initiated to explore the feasibility of capturing flood data using Unmanned Aerial Vehicles deployed in the field.

As rivers swelled and defences were overtopped across Cumbria, the project quickly evolved from theoretical research into practical fieldwork. Carlisle was initially selected as the test location, but the bureaucratic challenges of quickly flying UAVs over a city were significant.

Liaison with the Civil Aviation Authority, RAF and emergency services was all required and involved lots of paperwork. However, smaller rural towns impose fewer flying restrictions and, hence, fewer complications. As the timeframe in which to capture useful data tightened a new location was urgently sought.

Racing to the scene

Cockermouth provided the answer; a town where new raised barrier flood defences had held in some locations but at others, employing older defences, the Rivers Cocker and Derwent had overtopped. Monica Rivas-Casao of Cranfield University raced to the scene and using an AscTec Falcon 8 UAV was able to capture high resolution (2.9 cm) aerial photography across 98 hectares of the town. Although the peak flood event had passed, the survey detected clear evidence of flooding from the debris field and from the mud left in its wake.

The survey imagery was shared with the project group and photogrametrically processed into a high quality digital surface model. Using field observations of levels, a flood model was built using the terrain data. This effectively recreated the peak flood event and provided detailed depth and extent data for model validation purposes and for use in more detailed analysis of flooding mechanisms and for future defensive strategies.

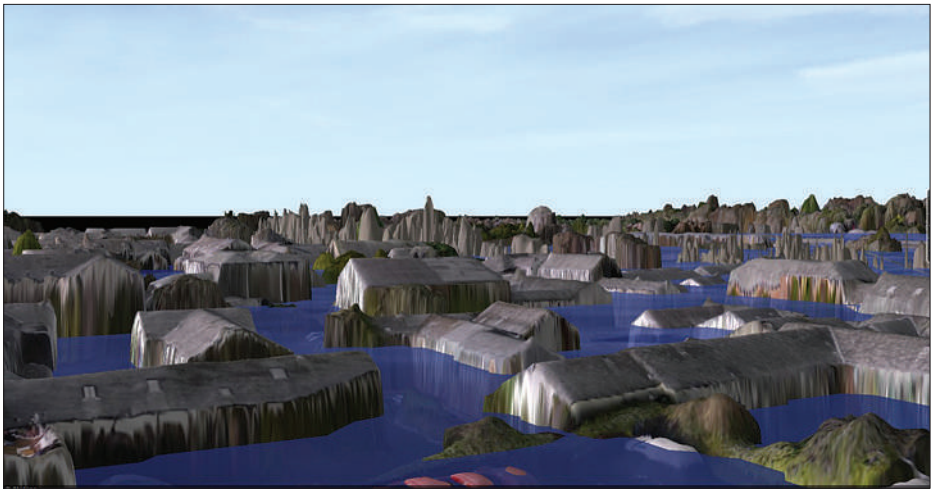
The exercise provided some very innovative and interesting results that should pave the way for future work around this theme. UAVs have the potential to map the extent and damage of flood events with very high accuracy. They can be deployed rapidly and affordably, and they offer considerable flexibility. This survey was at all times conducted under best practice guidelines and Civil Aviation Authority legislation. It was the first time ever that the CAA authorised UAV flights over congested areas for this purpose and, in so doing, proved the feasibility of using UAVs for flood research.

Better prepared

Future projects will look to monitor the evolution of floods as they unfold through multiple surveys. Oblique photography will also be taken to capture water levels and tide marks left against buildings. Through combining UAV surveys with flood models and remotely sensed satellite data, it will be possible to better prepare for and respond to flooding with more certainty as we face a distinctly uncertain future.

A route trace of the UAV survey flight path flown over Cockermouth

Wide overhead view of the photogrammetric digital surface model derived from UAV imagery displayed with simulated flood water levels from field observations



Close-up of the photogrammetrically-derived digital surface model derived from UAV imagery displayed with simulated flood waters levels from field observations

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