Improving urban flood prediction

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Heavy rainfall can cause flash floods in urban areas. While data from flood events is required to model such phenomena, water levels and discharges are not routinely measured above ground. Eawag now plans to make use of widely available images and videos to estimate these values.

We are all familiar with the chaotic scenes caused by torrential rain in towns – roads turned into raging rivers and sewers overflowing, unable to cope with the volume of water running off streets, squares and rooftops. In July 2017, for example, the historic old town of Zofingen (canton of Aargau) was completely inundated. Although modelling can be used to simulate flooding, the flood event data which is needed to calibrate, validate and improve computer models has been lacking to date. Generating such data is the goal of an Eawag project known as Calico (Calibration of Coupled urban flood models with experimental surface runoff data), which is supported by the Swiss National Science Foundation. Ultimately, data could be extracted from surveillance camera videos, or images posted on social media (Facebook, Instagram, etc.).

Experiments at a military training facility

To generate a reference data set for the development of new methods, flooding experiments were conducted by a team of researchers led by João Leitão and PhD student Matthew Moy de Vitry of the Urban Water Management Department. A military facility used by army and firefighting personnel for flood response training provided an ideal infrastructure for the team's experiments, with walls, basements, sewers, manholes and a street-like hard surface. As well as installing a variety of sensors, still-image and video cameras, the researchers parked a bicycle in the floodable area. João Leitão explains: "We can use objects such as bicycles in a photo or video to estimate water levels. Now we're training computers to do this too."

Extracting quantitative data from images

The team carried out almost 30 flooding experiments, collecting vast amounts of data in the process. They are now developing algorithms to allow flood discharges to be estimated from video data and also to determine whether water levels are rising, falling or unchanged. Explaining the principle, Leitão says: “We split the video footage into a series of images and, based on an artificial neural network, an algorithm recognizes the proportion under water in each image.” The algorithm for estimating water levels using bicycles in images is being developed by an ETH Master’s student. To validate the calculations, the results are compared with measurement data collected by sensors.

Improving flood risk management

With data from videos and photos of flood events, it should be possible to develop more reliable flash flood models for urban areas. This would enable authorities to identify areas at risk and issue early warnings.

Also crucial to the development of such models is a better understanding of urban water cycles through monitoring of rainfall, runoff and drainage. This is the goal of a field research lab established by Eawag in Fehraltorf – the Urban Water Observatory (UWO).

Related Links

Video on the flooding experiment

Moy de Vitry, M., Dicht, S., & Leitão, J. P. (2017). floodX: urban flash flood experiments monitored with conventional and alternative sensors. Earth System Science Data, 9(2), 657-666

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