Communicating Risk in Uncertain Predictions

Research Report

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Communicating Risk in Uncertain Predictions

Michael Cranston (1,2), Fiona Cuthill (1), Fiona Smith (2), Andrew Black (2) and Jackie Malcolm (3).
(1) RAB Consultants (Resilience and Flood Risk), Stirling University Innovation Park, Stirling, Scotland, FK9 4NF, (2) Geography & Environmental Science, University of Dundee, Dundee, Scotland, DD1 4HN, (3) Duncan of Jordanstone College of Art & Design, University of Dundee, Matthew Building, Dundee, DD1 4HT.

Introduction

Surface water flooding is becoming an increasingly common occurrence and will continue to increase as a consequence of population growth, urban expansion, and climate change. However, one of the main challenges for the flood forecasting and warning community remains the provision of reliable early warnings for surface water (or pluvial) flooding[2].

In 2014, the Scottish Flood Forecasting Service developed an operational pilot for a 10km by 10km area of Glasgow to provide responders with surface water flood forecasts during the Commonwealth Games to allow appropriate preparedness and mitigation measures to be implemented in a timely manner. However, communication of surface water flooding to residents of Glasgow was not included in the pilot project and was listed as a recommendation for future research to improve the resilience of local at-risk communities[3].

This report presents research, funded by the Centre for Environmental Change and Human Resilience (CECHR), aimed at supporting the development of new methods of communicating surface water alerts, incorporating uncertainty. The objectives were to:

- Trial a move away from the 'one size fits all' approach of communicating flood alerts currently adopted in the UK
- Set up a participatory workshop to test different methods of surface water flood risk communication including a new approach that was 'people-centred' and risk-based
- Analyse reactions, comments, and discussions to identify the most appropriate communication method to improve surface water flood alerts

Communicating uncertainty

The Glasgow pilot demonstrated the benefits in providing bespoke surface water forecasts, with targeted information on real-time surface water flood risk. However, Speight et al. highlighted the challenges for providing such a service includes the high staff resource requirement to support the service given the greater uncertainty in surface water flood forecasting, especially around the communication of the risk.

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[2] Cranston M, Speight L, Maxey R, Tavendale A, and Buchanan P (2015) Urban flood early warning systems: approaches to hydrometeorological forecasting and communicating risk. *Geophysical Research Abstracts*, 17, EGU2015-14598-1.
[3] Speight L, Cole S, Moore R, Pierce C, Wright B, Golding B, Cranston M, Tavendale A, Dhondia J, Ghimire S (2016) Developing surface water flood forecasting capabilities in Scotland: an operational pilot for the 2015 Commonwealth Games in Glasgow. *Journal of Flood Risk Management*, DOI: 10.1111/jfr3.12281.

Traditional approaches to flood early warning is to communicate a single (deterministic) prediction. Whilst warning messaging allows for the construction of messages to convey what is expected, they tend to be treated as a warning of an expected outcome. Ensemble forecasts on the other hand, provide a framework in which to identify a range of possible outcomes. How best to present the inherent uncertainty remains a significant challenge.

Commenting on a case in the US, Krzysztofowicz[4] notes that as forecasts are traditionally deterministic, they tend to create an illusion of certainty with forecast information. In one example, a prediction of a 49-foot flood crest was provided for the Red River in North Dakota which led to officials preparing for such as response. The actual crest of 54 feet was reached which resulted in forced evacuation and devastation to the city. Glassheim[5] reported on why such forecasts were interpreted with certainty leading to poor decision making:

> *"the National Weather Service continued to predict that the river's crest at Grand Forks would be 49 ft.…city staff prepared to combat the anticipated 49-foot crest…we believed we were ready. We learned afterwards that some experts…thought a crest of 53 or 54 feet was more likely than 49…if someone had told us that these estimates were not an exact science, we may have been better prepared."*

However, whilst reviewing challenges in communicating and using ensembles in operational flood forecasting, Demeritt et al.[6] highlighted a response from one flood forecasting agency that captures the challenge of decision making when communicating uncertainties:

> "*People cannot deal with uncertainties, it is too complicated. The problem is that to live, to go for a walk, to know whether we go to the picnic or not, we could cope with it. However, when it is time to decide whether we evacuate or not, it is another story.*"

In Scotland, the primary method of communicating early warning of flooding is through the Floodline service which uses Flood Alerts and Flood Warnings. Flood Alerts are provided for 19 large geographical areas covering all of Scotland and address all sources of flooding (river, coast, and surface water).

These remain the only method of public communication on the risk of surface water flooding other than the Met Office National Severe Weather Warning Service. In addition, SEPA and the Met Office provide a daily assessment of flooding through the Flood Guidance Statement. This does provide a risk-based approach, using the likelihood and impact risk matrices, that covers surface water flooding (see figure below).

A recent study into the effectiveness of the public flood warning service in Scotland[7] highlighted that whilst most customers valued the Floodline service, many felt some improvements could be

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[4] Krzysztofowicz R (2001) The case for probabilistic forecasting in hydrology. *Journal of Hydrology*, 249: 2-9
[5] Glassheim E (1997) Fear and loathing in North Dakota. *Natural Hazards Observer*, XXI 6: 1-4.
[6] Demeritt D, Nobert S, Cloke H, and Pappenberger F (2010) Challenges in communicating and using ensemble in operational flood forecasting. *Meteorol. Appl.* 17: 209-222.
[7] Geddes A, Cranston M, Ambler A and Black A (2017) *Assessing the effectiveness of Scotland's public flood warning service*. Report published by CREW: http://www.crew.ac.uk/publication/flood-warning-service .

sought. This included recipients of Flood Alerts – the only method of warning for surface water risk – who felt the need to receive alert information more geographically specific to their individual situation.

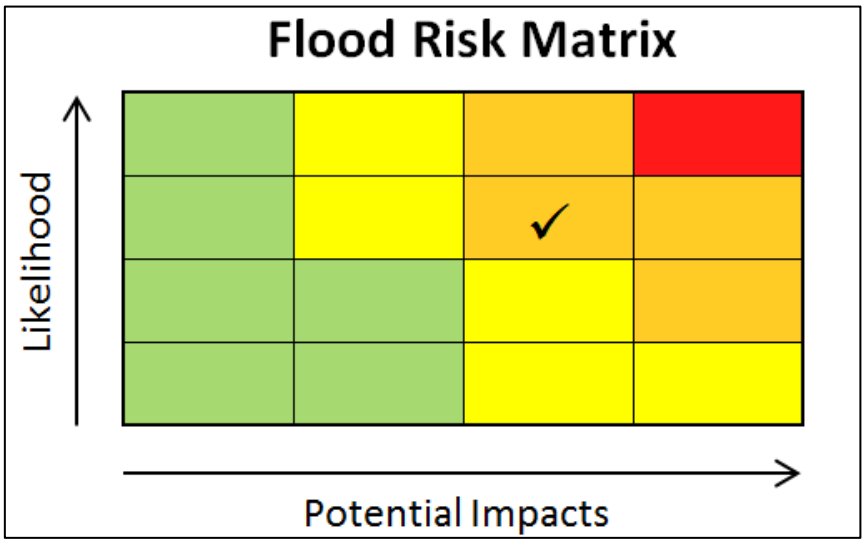

Figure 1: The flood risk matrix used by the Flood Forecasting Centre and the Scottish Flood Forecasting Service to communicate likelihood and impacts of flooding.

Methodology

Working across the interdisciplinary project team, a new pilot approach was developed for communicating surface water alerts. The objectives were to design something that:

- Is people-centred and risk-based
- Moved away from the 'one-size fits all' approach to presenting risk

Various approaches were explored; however, the final solution took inspiration from the nutritional warning labelling introduced by the Food Standards Agency in the UK. The common use of the new warning labels across the food industry has seen an improvement in consumer understanding of risk with the traffic light scheme being more accessible, and easier to interpret and helping consumers interpret percentages [8].

The approach developed as part of this project presents the individual risk, in percentage likelihood, of surface water flooding impacts to the individual receptors of:

- Individuals – disruption and impact on individuals
- Transport – disruption to travel and transport networks
- Property – risk of flooding to individual properties
- Communities – flooding affecting whole communities and disruption or loss of infrastructure

[8] World Cancer Research Fund (2010) *Traffic light labelling – helping people make healthy choices*. WCRF UK, London, UK.

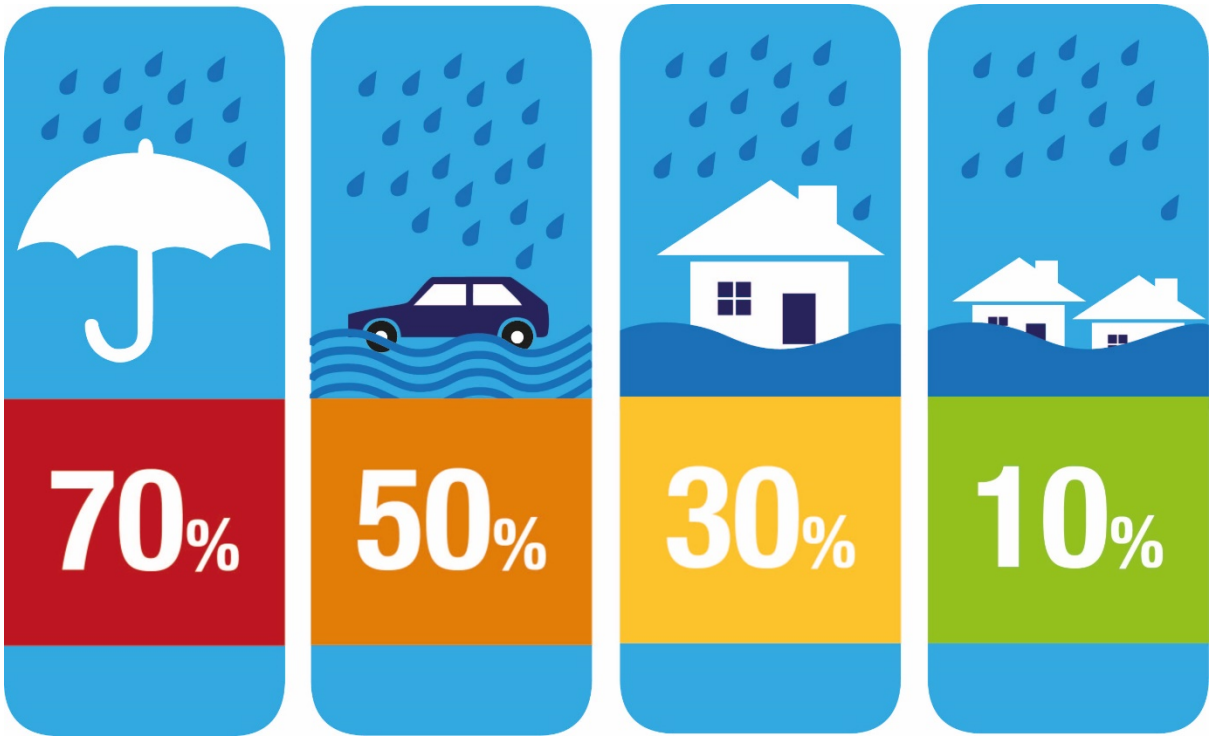

Figure 1: A new approach to presenting the risk of surface water flooding linked to different receptors: individual, transport, property, and communities.

This new approach was tested though a participatory workshop involving flood risk management professionals from Aberdeen City and Aberdeenshire Councils, SEPA and the Scottish Flood Forum. Participants were asked to respond to a series of structured questions to test their response to a Flood Alert, the Flood Guidance Statement, and the new approach. Each participant in turn would play the following roles:

- The Individual: You live in Aberdeen and have previously experienced surface water flooding to your property. As a result, you have recently purchased and fitted property level protection and resilience measures but have hitherto not had a need to put them in place. You work in Aberdeen and drive to your office.
- The Flood Engineer: You are the flooding and coastal engineer responsible for flood risk management at Aberdeen City Council. You have responsibility for watercourse and flood asset inspection and maintenance and are on call for responding to flooding related issues across the City.
- The Head Teacher: You are the Head Teacher of the local Primary School responsible for 200 primary school pupils. You are responsible for the wellbeing of the pupils and decisions regarding school closures. The school was badly affected by flooding two years ago following torrential rain in the city.

The responses that were sought from the participants included a range of decisions to be made. They varied from simple decisions such as deciding to take a waterproof jacket to work (individual) or placing watercourse inspection staff on standby (Flood Engineer), through to more difficult and

costly decisions such as proactively closing the School (Head Teacher). The responses to each decision were captured alongside discussion on the various approaches.

Results and Discussion

Graphics

Compared with the risk matrix presently used by flood risk professionals, the new approach presents a more graphical illustration of the risk and impacts which was appreciated by the participants of the workshop. The views included:

> *"This should be easy to understand by all, especially the public, 'a picture says 1000 words' and that personal safety risk is easily identified…the graphics would prompt different responses from the public rather than the current alert, they would take notice."*

The participants also felt that the new approach could be adopted and used by them to raise awareness of the potential for surface water flooding:

> *"The new method could be used and posted on social media…this is a great method of portraying information to the uninformed."*

However, some participants did also raise concerns about the clarity and meaning of the individual graphics:

> *"The graphic relating to individual property against community needs clarified as there may be a scale and perception issue. The graphic relating to a flood event affecting the community looks like the alert for a big flood. The graphic showing a single house looks like it represents a small flood and not an individual house."*

Scale

The scale at which surface water alerts are applied are a concern, with the participants emphasising the need to focus on smaller areas:

> *"Understanding the (current) Flood Alert is difficult – are they issued for the city or the catchment? In the case of Aberdeenshire, the alert is difficult to interpret because of the large area the Council covers."*

For the new approach, scale at which to apply the surface water alert was discussed:

> *"For the new method to be successful, Aberdeenshire would need individual alerts for different towns and Aberdeen City would need 2 or 3 alerts for different parts of the city."*

However, it was suggested that whilst the surface water risk on any one day may be the same across large parts of local authority areas, the same alert could be issued to different towns or parts of the city so residents think they are getting a bespoke surface water alert, which may improve their willingness to respond.

Understanding of Risk

Whilst the Flood Guidance Statement (FGS) presents more information on the risk of surface water flooding (likelihood and impact), responses to some of the decisions in the exercise meant they were less likely to take direct action on the FGS when compared to the Flood Alert. This included being less likely to close the school, or proactively seeking to close roads. Elements of this less proactive action were explored in the comments:

> *"Words like 'low' and 'very low' don't mean anything to those responding to the possible event…we look at the impact-likelihood table daily…if there are no red, amber or yellow colours then it's dismissed."*

Regarding the new approach, some suggestions were offered as potential improvements, including:

> *"Could you display the percentage as a fraction e.g. 1 in 10 chance. This may be more relatable and hard-hitting as a fraction."*

> *"Why not remove the colours from graphics and just have the percentages? The may be a conflict of different communication methods, colours and percentage sometimes conflict, i.e. green and 10%."*

> *"Why not include 'high', 'medium', or 'low' risk at the bottom along with the percentage of the risk?"*

Decision making

The broad agreement from the group was that making decisions on surface water predictions is difficult. If Flood Alerts are issued for Aberdeenshire and Aberdeen City then little action is currently taken.

> *"If an Alert is issued 24 to 12 hours in advance, often nothing is done because there's no confidence in the alerts. We won't deploy anything until the rain starts…we would monitor using the Met Office's Hazard Manager."*

However, when testing the responses to Flood Alerts and the Flood Guidance Statement for a specific example which referenced the potential for surface water flooding, most were likely to prepare "road closed" signs and inspect and clear culverts where flooding is known to occur. One participant commented:

> *"We can issue warnings such as 'don't drive cars down x street', but physically protecting a house from surface water flooding is a challenge due to the uncertainties in predictions and vagueness of alerts received."*

When discussing decision making using the new approach, participants questioned what would trigger the surface water flood alert:

"How high should the percentage risk be in order that an alert is issued? For example, is it worth issuing an alert if risk is below 30%. It would be worth testing percentages with the public, e.g. 10%, 20% etc. and find out how the public would respond"

Recommendations

1. Review the comments on the new approach to surface water alerting and refine the graphics and presentation
2. Carry out wider public testing of the new approach. Note: Aberdeen City Council has offered to support testing with flood groups in Aberdeen
3. Consider how this research fits into wider research on flood warning communication (review of Flood Alerts) or future developments (SEPA's public flood guidance statement)

Conclusion

This report presents exploratory research to develop a new method of communicating surface water alerts with uncertainty. The method trialled a move away from the 'one size fits all' approach of communicating flood alerts currently adopted in the UK, to a risk and impact-based approach to communication.

A participatory workshop was held to analyse reactions, comments, and discussions to inform the most appropriate communication method to improve surface water flood alerts. Initial responses to the new approach have been encouraging suggesting the method is easy to understand and could encourage action. However, some feedback on further refinement has been suggested and further testing with a much wider group of public participants has been recommended.

Acknowledgements

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