Using social media to enable stakeholder communication during floods

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I. Executive Summary

This report describes the work performed and outputs achieved by the CRUISSE-funded project titled above. Project goals were largely achieved as planned. A social sensing prototype was developed in collaboration with the Flood Forecasting Centre as a key stakeholder. The tool was evaluated positively and may be developed in future for operational use. The project has helped us to understand the process of research translation from lab to end-user application and we provide some thoughts which may be valuable for funding bodies and policy makers. A key goal of the forecast community is to move towards 'impact based forecasting'. We describe how our methods work to reduce uncertainty around measuring impact (type and magnitude), improve forecasts and hence downstream decisions.

II. Background

We responded to a call co-created by the National Flood Forum and the CRUISSE leadership designed to explore evidence around streamlining multi-stakeholder interactions in a situation of radical uncertainty: flood risk management. The NFF stated in the call that it works closely with national and local government agencies, flood protection companies and the insurance industry, as well as flood action groups to ensure that the views and issues of those at risk of flooding are taken into account when decisions are made. We responded to this call with a proposal aiming to test if real time analysis of social media could add to locally relevant information as to the uncertain presence or worsening of floods in a local area.

We began by talking to the NFF people responsible and CRUISSE. Based on these meetings we decided to focus on building a tool for use by flood management professionals, rather than the general public. To build this tool we used the methods developed in previous work [2, 3] which is part of the much larger social sensing literature e.g. see [1]. Our previous work established contacts with the Flood Forecasting Centre (FFC) a Met Office/Environment Agency group specialising in flood risk. The culmination of the project was the 'live' deployment of our tool then an evaluation from the FFC regarding its potential use operationally and as a verification tool. The outcome of this evaluation was very favourable and we are currently hosting the service online for their continued use `https://rudyarthur.github.io/socialsensing/` and the FFC are planning to incorporate this tool more formally into their monitoring and evaluation processes.

III. Report Summary

We identified social sensing as a useful tool for decision makers to aggregate information from the public and two obstacles to putting it into practice: building a friendly user-interface and a demonstrating its power to stakeholders.

Our initial plan was to build an app for the general public, however this was scrapped due to several concerns: probable low engagement, app over-saturation and the technical competence needed to interpret the output. Instead we decided to pivot and exploit our relationship with the Met Office and Environment Agency, in particular the Flood Forecasting centre, and develop a more specialist tool.

The FFC's main product is the Flood Guidance Statement (FGS) which is issues to Category 1 and 2 responders to aid in their planning activities. In addition the FFC always has an on-call person to monitor rain radar, river gauges etc. and notify the appropriate channels in the event of unforseen flood events. We made our goal to demonstrate how social sensing could improve both of these FFC processes. We realised that by deploying social sensing in real time we could add a 'social-gauge' to the array of monitoring tools available to the on-call person. By providing the ability to look back a few days we enable the FFC to do a better job in verifying their predictions and evaluating their impact forecasting models, ultimately improving the quality of the FGS.

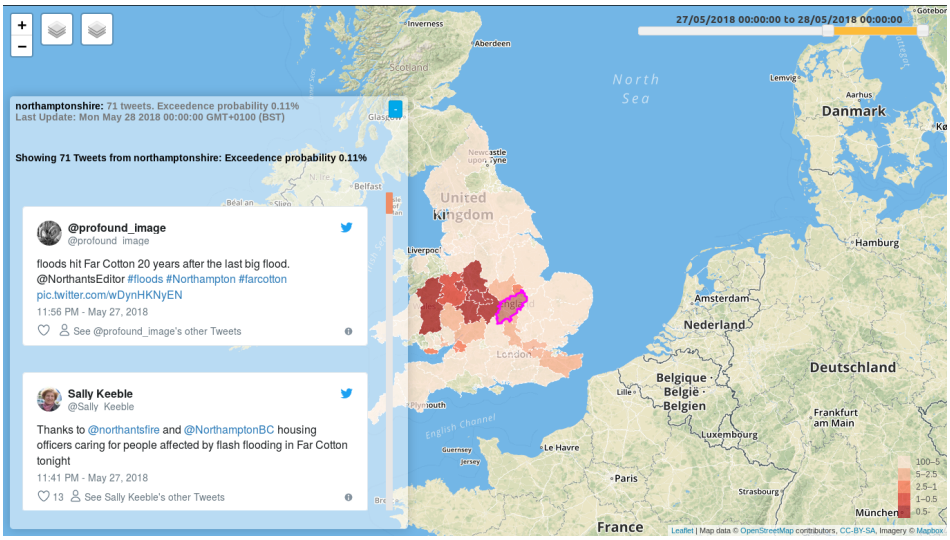

Figure 1: Final social-sensing interface.

The social sensing prototype was developed, see figure 1, and contains several layers: raw counts or exceedence probabilities (i.e. 1 in 100 day etc.); coarse, fine and county gridding; time windowing as well as the ability to read the original social media posts which generated the event spikes.

The FFC then performed an evaluation exercise where the tool was met with wide interest within the FFC and across the broader Met Office/Environment Agency community. Several minor improvements were suggested however the prototype as it stands is useable and fit

for purpose. In the evaluation it enabled, on a number of occasions, the on-call monitor to notice an unfolding flood event that might otherwise have been missed.

IV. Outcomes

The main outcomes of this project were as follows

- An alpha version of a user-friendly flood-impact visualisation tool, built on pre-existing research code
- Establishment of a good working relationship with an important group of end users and a branching out of interest into the wider forecasting/flood response community.
- A formal evaluation of the tool by a key group of stakeholders.

More generally, in line with CRUISSE's remit to deploy academic insights to study and reduce radical uncertainty we have found that within the institutional flood management community there is a large body of hydrology and meteorology that enables accurate predictions of water levels, with standard associated statistical uncertainty.

However within the FFC and across the forecasting community there is a move to transition to 'impact based forecasting'. Here new variables come into play, often grouped under the term 'exposure' or 'exposure fields'. At the simplest level an exposure field could just be a population density map - a flood in a densely populated area, definitionally, affects more people than in a sparsely populated one, and therefore intuitively has a larger impact. However things become more complicated as other variables are considered. For example a power station may be in a sparsely populated area, but a flood affecting operations can have a huge impact. Another example is an area which is accustomed to flooding versus an area which rarely floods. A flood of the same magnitude, affecting the same number of people can have vastly different impact.

In order to produce impact based forecasts, impact must be measured! This is currently done via proxies like population but the true exposure fields relevant for flooding are only beginning to be mapped. The type of uncertainty here is characterised by a huge number of interdependencies e.g. flooded roads affecting hospital admissions, and spatio-temporal heterogeneity e.g. floods on a Sunday may have a different impact profile than floods on a Wednesday.

This mapping of impact and exposure is of crucial importance in planning, decision making and deployment of resources. We have found, among the FFC and other groups, information gathering is a very time consuming task, still performed manually. In order to start to deal with this uncertainty, automating this data collection process is crucial. This allows the collection of big-datasets and the tools of data-science allow us to summarise these in useful and interpretable ways. Better data helps prioritise improvements in modelling, as well as operational procedures. Improving impact data collection therefore leads to reduction in uncertainty around flood risk and allows all downstream users to make better decisions.

In terms of the process of research translation we have also made the following observations, which will be of interest to academics, funders and policy makers.

- Institutional stakeholders, even if they have the technical ability, do not have the time or inclination to work with academic software.
- A concerted effort in development and consultation with potential end-users is an absolute necessity and this is not a quick process!
- Institutions do not want to manage a new tool themselves and sometimes are not permitted to do so due to security issues. This means that academic outputs require an additional effort of translation/innovation if they are to be used beyond the research lab.

More support for this process at the university level and in terms of funding would be extremely beneficial.

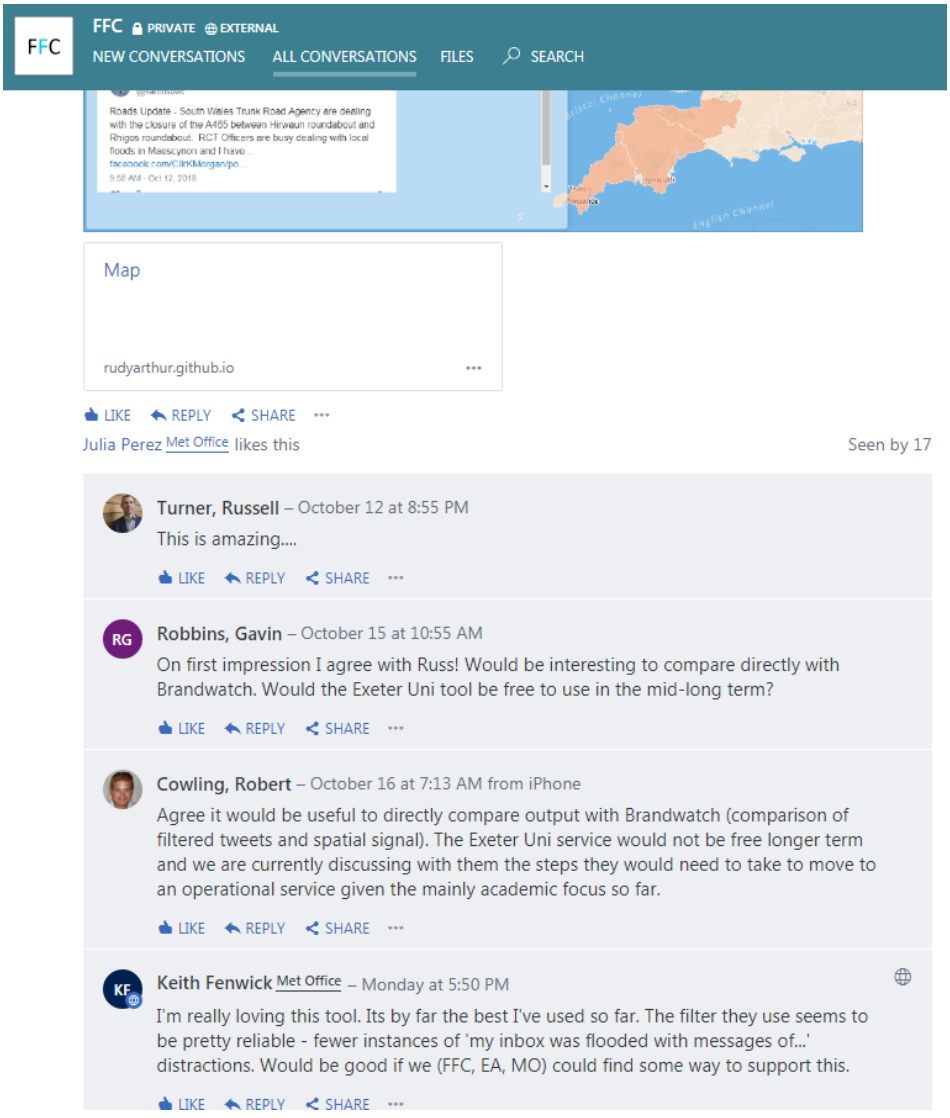

Figure 2: Discussion during the evaluation process.

We have already written up the main novel methods of this study in an academic paper [3]. The main tangible outcome of this project is the prototype user interface: `https://rudyarthur.github.io/socialsensing/`, the evaluation by the FFC and the interest generated in social sensing methods, figure 2.

V. Future Work

We have gone a long way towards getting this tool out of the ivory tower and into use. Our alpha version is currently being used as is. There are two interesting future directions. The first is to take the final steps to build social sensing into the FFC's processes in a formal way. This will likely require partners who have experience in delivering robust services. The will to do this exists and the FFC are currently close to securing funds to drive this forward.

The second path is to extend this methodology to other hazard types e.g. wind storms, and to other locations. We currently working with the Met Office Global Hazards group who are very interested in social sensing from a verification standpoint. The prototype developed under this project has been invaluable in helping us to demonstrate the potential of these methods and will likely be part of future collaborative efforts and any academic papers resulting from these collaborations.

References

[1] Sakaki, T., Okazaki, M. and Matsuo, Y., 2010, April. "Earthquake shakes Twitter users: real-time event detection by social sensors." In Proceedings of the 19th international conference on World wide web (pp. 851-860). ACM.

[2] Boulton, C. A., Shotton, H., and Williams, H. T. 2016. Using social media to detect and locate wildfires. In Tenth International AAAI Conference on Web and Social Media.

[3] Arthur, R., Boulton, C. A., Shotton, H., and Williams, H. T. 2017. Social sensing of floods in the UK. PLoS ONE, volume 13, no. 1