Estimating risk bands using flood event data

Environmental Modelling in Industry Study Group
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Challenge summary

Understanding the chance that a property will flood is fundamental for deciding which projects get funded. Usually we use flood models to estimate flood probabilities. But models are expensive to build, making some small projects prohibitively expensive. Could we use statistics instead, to get an answer that is good enough?

If a property has flooded 30 times in 30 years then we could be confident that that property is at risk of flooding. Even without building a model. But what about if the property had flooded 5 times in 10 years? Or 3 times in 5 years?

We are looking for a tool that takes data on flood events over a period of time. In return it estimates which of five probability bands the property falls in to, along with an estimate of confidence.

How are flood risk management projects funded?

In 2014, Defra published the partnership funding calculator. The calculator brought some real advantages by making the process of funding much clearer. Users enter in to the calculator the outcomes they expect to deliver as part of their project. Based on those outcomes, the calculator provides a figure showing the total amount of funding available for delivering those outcomes. Users can compare this figure to the cost of their scheme to see if it is viable for funding or whether they need to seek contributions from elsewhere.

The calculator covers a broad range of possible outcomes such as economic benefits and environmental improvements. However, dominant factor in the assessment, by some margin, is the number of properties moved from one flood band to a lower probability band.

The four bands and their associated probabilities are:

Band name	Lower bound	Upper bound
Very significant	1 in 30	1 in 1
Significant	1 in 100	1 in 30
Moderate	1 in 1000	1 in 100
Low	0	1 in 1000

Why is this approach a problem for some practitioners?

The approach in the partnership funding calculator assumes that you have good evidence to show which flood band properties. Typically this evidence would come from a detailed flood model and an economic analysis. If you are building a multi-million pound flood defence scheme, you have probably already invested in gathering that information.

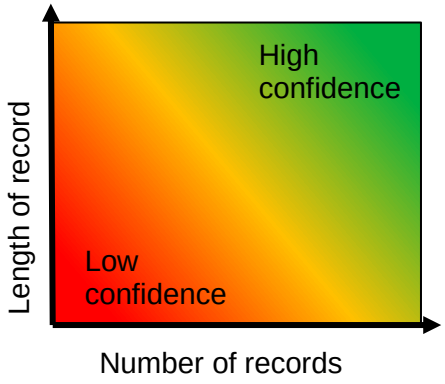
However, many practitioners want to focus on smaller schemes like natural flood management or Sustainable Drainage Schemes. Some of these schemes might only have a budget of £10,000. In these cases, the cost of building a detailed flood model would leave no money for protecting people from flooding.

So we need another method of estimating the correct flood band that is proportional to the level of funding sought.

Using historical records of flood events

Few communities have access to detailed flood models. However, many of them keep records of significant flood events. If a property has flooded 20 times in 20 years, then you don't need a flood model to tell you that it is in the very significant flood band.

However the situation becomes more complicated when you have a shorter record of data or fewer flood events in the record. Which band is 2 floods in 2 years? What about 2 floods in 100 years? The diagram below illustrates how the historical flood record could affect our confidence in the estimate of flood band.



Statistical confidence that flood risk falls in the Very Significant Band (>5% chance)

(Note - Relationship and method of presentation is for illustration only)

There will always be some uncertainty about which band a property falls in to. But the assessment might be good enough for a small amount of funding. If we know how much confidence we have in the assessment then we could set confidence thresholds specific to various levels of funding.

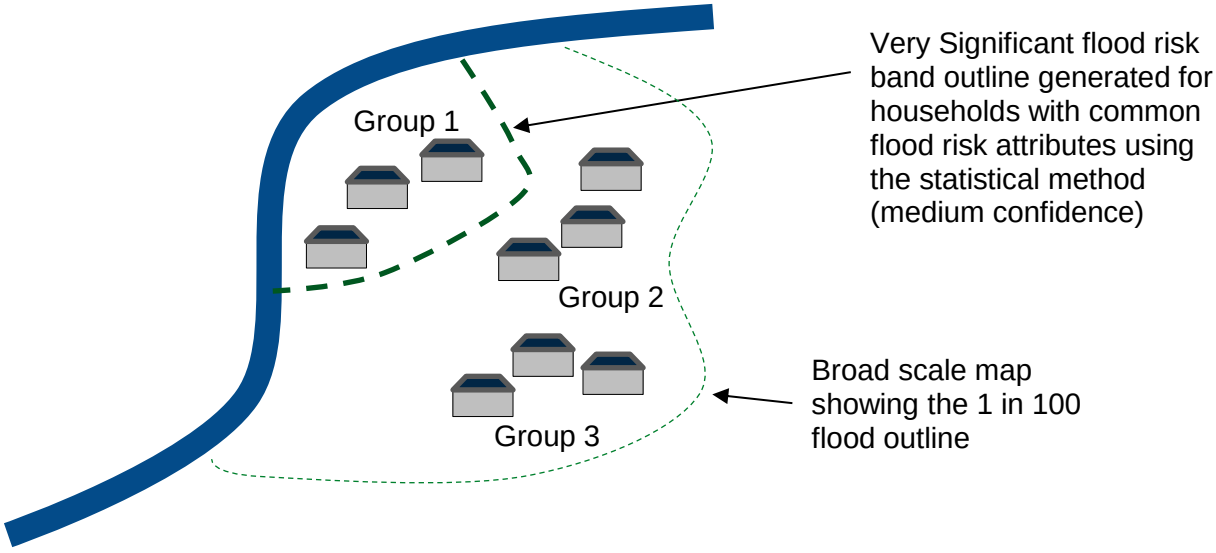
An example

A small community has a history of flooding and they would like to implement a flood risk management scheme. There are no existing detailed flood models for the catchment. To develop one would be disproportionately expensive. Broad scale flood maps do exist, and are some help, but they do not identify properties in the very significant band. These are the properties that will benefit most from the scheme and the properties that will drive funding estimates through the partnership funding calculator.

The record of flood events is shown in the table below:

House group	Flood record	Number of Events	Confidence property is in the very significant band
1	2015, 2006, 1991, 1987, 1964, 1951, 1936	7	Medium
2	2015 1991 1964 1936	4	Low
3	2015 1936	2	Very Low (or high it's not)

Using the local flood history, the statistical relationship indicates a medium confidence that house group 1, are in the Very Significant band. This is consistent with broad scale mapping, which gives further confidence in the result.



This is sufficient evidence for the initial flood risk and funding baselines in a business case for a small FCRM scheme to protect housing group 3. The Evidence was not strong enough to include house groups 2 and 3. More detailed modelling might show otherwise, but would require further investment.

How could a flood record be misleading?

Artificially shortened records - It is important that the flood record last for as long as we have records of flooding, or not flooding, that are relevant to the current condition of the catchment. For example, imagine a property that has flooded every year for the last five years, but never before then in recorded history. This property should be in a different flood band than one that was newly built five years ago and has flooded every year since. The flood record should include the years where no flood occurred rather than just the length of record of floods to ensure a fair comparison.

Multi peaked flood events - Sometimes a single flood event could lead to multiple instances of a property flooding. For example a property by a tidally influenced high flowing river could flood twice a day, every time the tide is high, until the river recedes. This should be counted as one flood event, but could appear as multiple flood events in the record.

What do we need from Maths Foresees study group?

We are looking for a simple tool where we can input a list of dates of flood events and in return receive the confidence that a property falls in to each of the four flood probability bands: very significant, significant, moderate and low.