Surface water management plans – more than just modelling

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Abstract

Surface Water Management Plans are one of the main tools for local authorities to deliver their new responsibilities for dealing with local flood risk. Successful SWMPs require all stakeholders (including water companies) to work together to define risk and to implement solutions.

SWMPs do require modelling to help to define flood risk but they also need to be linked to real data of past flooding to confirm the risk. In recent studies we have developed a useful way of integrating knowledge of risk from different sources.

There are several challenges to integrating practice for SWMPs with water company practice for assessing flood risk. This relates particularly to the framework for flood damage cost and the risk from sewer blockage.

Legislation and other drivers

There are two pieces of legislation that underpin the need for Local Authorities to carry out Surface Water Management Plans.

- The first is the European Floods Directive, which is transposed into UK law as the Flood Risk Regulations. This was originally intended to address issues of cross-border river flooding following the major European floods of 2004. However its scope has increased to cover all sources of flooding.
- The second is the Flood and Water Management Act (FWMA) which puts new duties on local authorities to investigate and act on local flooding risks. This came out of the Pitt Review into the major floods of 2007.

The two pieces of legislation are effectively equivalent although there are some differences in wording to give the lawyers something to argue about. The FWMA act does not include any timetable for delivering SWMPs but the European legislation includes an explicit timescale for three stages of delivery:

- Identification of areas for investigation – June 2011
- Definition of risk for these areas – June 2013
- Plan for action – June 2015

There are two other drivers for action on local flood risk.

- The insurance industry currently has an agreement to continue to offer affordable flood insurance to householders. This expires in June 2013 and its extension will depend on a commitment to reduce flood risk to insurable levels.
- Sewerage undertakers have an important role in managing local flood risk and they will need to include schemes in their 2014 business plans if they are to obtain Ofwat approval for funding them.

Scope of SWMPs

SWMPs are different in one key respect from previous Local Authorities work on flood risk such as Strategic Flood Risk Assessments. These were intended to control development to avoid increasing flood risk. SWMPs include the scope for reducing existing flood risk.

SWMPs look at all sources of flooding except for flooding from main rivers. This includes overland exceedence flows, watercourses, flooding from sewers and groundwater flooding. The scope for flooding from sewers includes flooding due to blockage and collapse except for

dry weather flooding. There can therefore be a temptation for them to develop into a blame game with parties limiting their responsibilities to "their" flooding. This is not the intention and the FWMA explicitly sets out duties for organisations to collaborate.

SWMPs remit cover all probabilities of flooding including flooding in extreme events. In particular they have focussed on 1:100 and 1:200 year probabilities. They therefore go beyond the standard design criteria normally adopted by the water industry.

Method

Guidance on carrying out SWMPs has been published by Defra and is based on a cycle of investigation, action and review. This is the SWMP wheel.

The guidance was reviewed after initial trial applications and the guidance was modified to add an iterative process for the risk assessment with increasing levels of detail.

Our experience from the plans that we have developed so far is that in fact this iterative process needs to cover the steps before and after the risk assessment as well from selecting the approach to preliminary assessment of options.

SWMPs explicitly require a benefit-cost assessment to compare the cost of any proposed options with the reduction in flood risk that they deliver. This is used to demonstrate the benefit of the options and priorities different schemes for the available budget.

An additional step of the SWMP that is not included in normal Water Company sewerage planning comes from the multi-stakeholder involvement in SWMPs. Before doing anything, it is therefore necessary to build a partnership to establish and implement the plan. The partnership needs to include local authority highways, drainage and planning (both tiers of local authorities in two tier areas) the sewerage undertaker, the Environment Agency, key landowners, residents groups, local politicians.

Setting up this partnership can be a challenging step and needs to address aspects including; data sharing, decision making protocol, timescales, local priorities, sources of funding, ownership and maintenance of solutions.

Modelling

There are five main steps to modelling for surface water management plans.

1. Calculate the depth of flow on the ground surface

2. Assess which properties are flooded due to that flow
3. Verify the depth of flow and flooding against historic information
4. Calculate the cost of the impact of the flooding
5. Integrate the cost across return periods to give the total value of the flood risk.

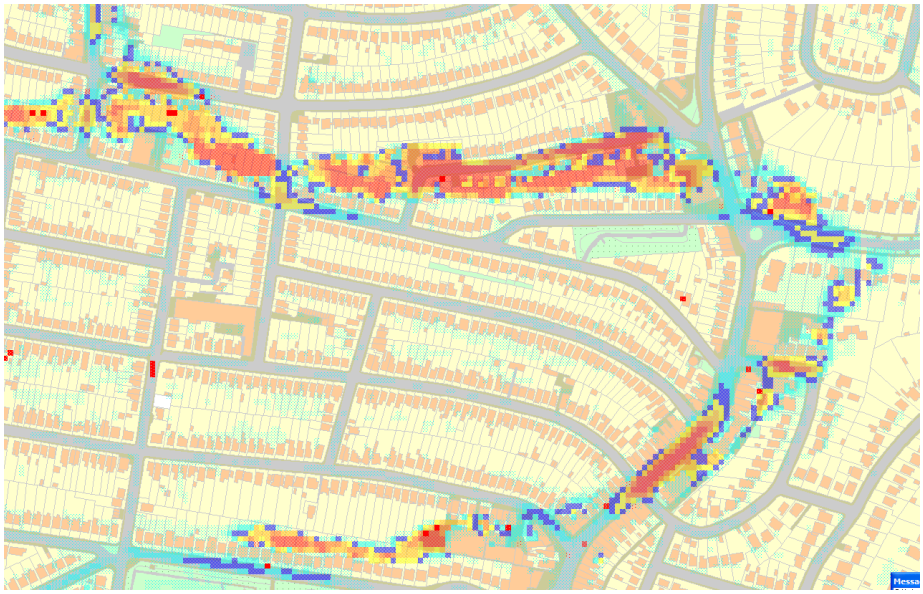
Potential improvement works can then be assessed to identify what they will cost and what reduction in risk they will provide. A benefit-cost assessment then allows preferred options to be selected.

Calculate the depth of flow

There are several models capable of representing surface water flood flows including the Mouchel FRM model. There is a balance to be found between accuracy and flexibility of the model against the run time for the simulations.

If a separate surface water model is being used that is not linked to a pipeflow model then it is important that it does represent the loss of flow to the pipe system in some form.

All of these models eventually produce a map of maximum flood depth across the catchment surface.



This example is from the FRM tool, which represents the obstruction to the flow caused by buildings. There are therefore islands within the flow paths where there is no flooding as they are under buildings.

Assess which properties are flooded

Assessing which properties are flooded may seem like a simple task. We just need to compare the flood level at the property location with the floor level of the property. The difficulty is that we don't generally know the floor level for properties and, for a model that includes the obstruction of a building to the flow, there may be no flood level within the building outline but will be immediately adjacent to it.

It is therefore necessary to make some assumptions about the threshold level of the properties and also define rules to look at the flood levels around the buildings as well as directly at the location of the buildings.

There is no standard approach to these rules and they can have a significant impact on the assumed flood impact. As an industry we need to develop an agreed procedure for this part of the process.

In critical areas the initial estimates can be improved by surveying actual threshold levels of at risk properties and using these to assess flood impact.

Calculate damage cost

The costs of flooding impact on many different stakeholders and can cover both tangible and intangible costs.

For SWMPs valuation of flood damage is based on *The Benefits of Flood and Coastal Risk Management - A Handbook of Assessment Techniques* (The Multi-Coloured manual) published by Defra. This provides information on domestic properties, non-domestic properties, roads and additional operational costs for responding to flood incidents. This gives great detail on tangible costs of damage – the costs of repairing properties and contents but has a very simple approach to intangible costs based on a type of willingness-to-pay survey of focus groups.

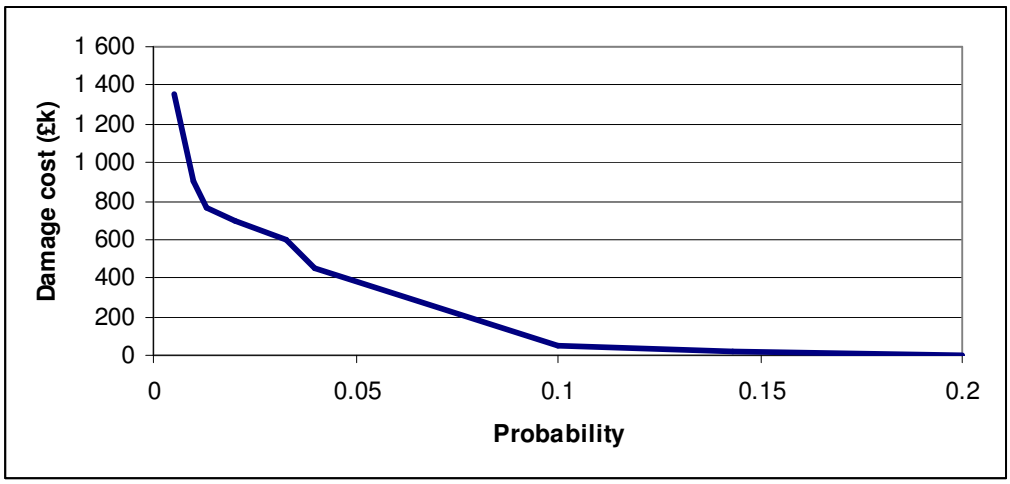
This approach is rather different from the Water Company approach where the willingness-to-pay results are the main part of the valuation of flood damage and often the physical costs are ignored as being carried by the insurance industry.

The guidance from both Defra and Ofwat is that risk assessment should include the costs to all stakeholders both tangible and intangible. The two frameworks should therefore align; but currently they do not.

There is a need to develop a coherent framework for calculating flood damage that all parties can use and justify to their regulators and paymasters. We have started to look at this issue for Severn Trent Water but more work is needed across the industry to finalise this ready for use at PR14.

Integrate damage to risk

Flood risk is not due to just one storm with a known probability; but to a whole range of storms of all possible probabilities. This therefore gives an envelope of flood damages with the magnitude of the damage varying with the probability. An example of this is shown in the figure below.

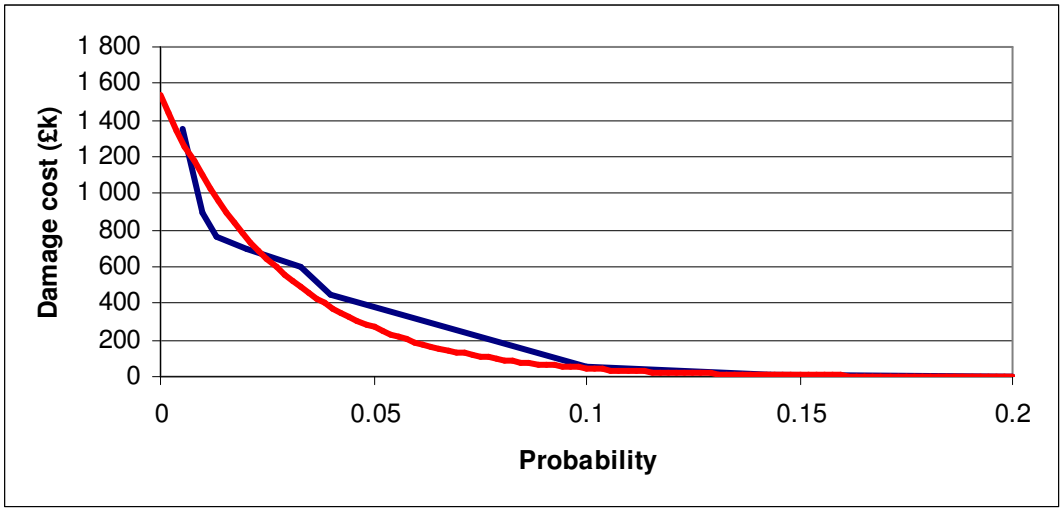


It can be seen that the line of the graph approaches but never reaches zero with either axis and tails off to infinity. At very low probabilities (high return periods) there is a large damage cost but the probability tends to zero. At high probabilities (low return periods) the damage also tends to zero.

The risk from each event is given by the probability multiplied by the damage cost. The risk from the whole range of events is therefore given by the integral of damage cost against probability; that is the area under the curve. This is the Expected Annual Damage (EAD).

The normal approach to calculate EAD is to analyse several storms of different probabilities and integrating the area under the line using the trapezium rule. We have developed an alternative method of fitting an exponential line to the damage curve and integrating the equation of the line. This offers two benefits.

1. The calculation can extend the assessment to the damage from very low probability high damage cost events where the line reaches the axis. This is shown in the figure below.



2. The other advantage is that data points from other information on flooding can be added to the dataset and automatically adjusts the curve and the damage cost. So for example cost from past flooding can be added and integrated with the model results. The technique allows for different confidence scores to be applied to the different sources of flood data to provide an appropriate balance between model and real world information.

Verify model results

As with all modelling it is important to verify the results of the model against real world information. This is particularly important for surface water management plans because of the uncertainties of all of the input data. It is not feasible to check every flooded property but areas with historical reports of flooding should be reviewed and site reviews carried out for significant clusters of flooded properties to confirm approximate threshold levels and flood risk.

Learning from studies to date

The SWMPs that we have carried out to date have delivered some useful learning points and I am sure that others have also learned from their studies. The challenge now is to pool this learning and develop improved methods for future SWMPs. Particular learning points that we have identified include:

A large proportion of the total flood damage risk appears to come from relatively high probability flooding with probabilities of 1:10 or 1:20 year. The larger less frequent events have a smaller contribution to the total flood risk.

For these more frequent storms the capacity of the piped sewerage system (including its blockage risk) has a significant impact and so collaboration is needed between Local Authorities and Water companies to deal with this risk.

Water companies and local authorities are using significantly different frameworks for defining risk and benefit and collaboration is difficult until these are integrated.

Water companies and local authorities both have issues around making detailed flood risk information available to customers and residents. Some local authorities are prepared to be much more open than water companies have considered.

The solutions to the flooding risks identified during SWMPs will involve the retrofit of new drainage features to the existing urban system. These will almost certainly need to include above ground sustainable drainage features to give an affordable long term solution.

Water companies will need to build the results of SWMPs into their business plans for the next periodic review to show that they are responsive to local needs and local strategies.