

# The significance of available data for the production of robust Strategic Flood Risk Assessments

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## Abstract

Strategic Flood Risk Assessments (SFRAs) form part of the evidence base for Local Development Frameworks and are required by Local Authorities to inform their Core Strategies. The aim of SFRAs is to assess the risk of flooding from all sources of flooding, including fluvial, tidal, surface water, groundwater, sewer and artificial water bodies. This paper investigates the constraints with respect to several key areas, including stakeholder engagement, data availability and quality, legislation and guidance, and wider issues. Recent examples are drawn for to identify issues in the application of a consistent approach when undertaking such studies across single or multiple districts. In addition, an investigation of the assumptions used has been made when undertaking district-wide studies where, in some instances, limited data are available. It is suggested that a pragmatic approach should be adopted where data availability is limited and be proportionate to the risk from the given source.

## Introduction

Significant social, economic and environmental effects can be a consequence of flooding from a range of sources, including fluvial, tidal, surface water, groundwater, sewer and artificial sources (Finch *et al.*, 2004; Coulthard *et al.*, 2007; Gens and Alonso, 2006). Recent flooding events within the United Kingdom, including the Easter 1998, Autumn 2000 and Summer 2007 floods, have highlighted the requirement for a greater understanding of flood risk at the strategic level.

Within England, Planning Policy Guidance Note 25 (PPG25): *Development and Flood Risk* (Department of Transport, Local Government and Regions (DTLR), 2001) was published in July 2001 and introduced the responsibility for Local Planning Authorities (LPAs) to ensure that flood risks were understood and the adoption of a risk-based approach to effectively manage these within the planning process. In terms of SFRAs, there was no explicit requirement for LPAs to undertake these studies and the Environment Agency did not have statutory powers to object to planning applications in areas at greater risk of flooding.

Although under PPG25 LPAs were not explicitly required to undertake SFRAs, in certain areas where flood risk formed a significant driver alongside other policy considerations, such studies were undertaken. Due to a lack of formal guidance accompanying PPG25 as to what information should form SFRAs, local guidance documents have been developed (Environment Agency (Yorkshire Region) and Yorkshire and Humber Assembly, 2004, Environment Agency (North West Region) and

North West Regional Assembly 2004). Subsequently, formal guidance was produced through the Defra/ Environment Agency Research and Development Programme for Flood and Coastal Defence (Defra/ Environment Agency, 2005).

Following the *Making Space for Water* Consultation (Defra, 2005), changes in legislation were enacted and Planning Policy Statement 25 (PPS25): *Development and Flood Risk* (Department for Communities and Local Government (DCLG), 2006) was released. This guidance reinforces and strengthens the responsibilities relating to flood risk contained within PPG25 and applies to all tiers within the planning system from regional to site-specific spatial scales. In addition, LPAs are now required to consult the Environment Agency on all planning applications in flood risk areas as defined within PPS25.

As part of the evidence base used within the Sustainability Appraisal to inform their Core Strategy, LPAs are now required to undertake Strategic Flood Risk Assessments (SFRAs) under PPS25. The aim of these strategic studies is to assess the risk of flooding from all sources and guidance has been provided in the form of a practice guide companion to PPS25 (DCLG, 2007). The practice guide companion has been through a consultation process and an updated version is expected for release in June 2008. This paper considers the constraints associated with such studies and the application of assumptions in the assessment of flood risk at a strategic scale.

Recent advances in numerical modelling at the strategic scale (Bradbrook, 2006), coupled with localised hydraulic modelling and observed extents of past flooding provide good estimates for the delineation of Flood Zones as

described within PPS25. Although fluvial and tidal flooding is relatively well defined for the purposes of SFRA, the representation of flooding from other sources is less well understood for the application in these studies. Increased research into other flooding sources has been promoted through *Making Space for Water* and results of these studies are contributing to this understanding (Hankin *et al.*, 2008)

### SFRA Process

The production of SFRA can either be a single stage process where a ‘Level 1’ is used to inform spatial planning through the application of the Sequential Test as defined within PPS25; or, where no reasonably available sites can be identified in areas of lower flood risk to meet development targets of the LPA, the scope of a SFRA can be widened by undertaking a ‘Level 2’. The objective of a Level 2 SFRA is to reduce the uncertainty regarding flood risk for development sites that require application of the Exception Test. Figure 1 shows the typical process involved in the production of SFRA.

### Data collection and constraints

Within the SFRA process, constraints exist such as stakeholder engagement, data availability and quality, legislation and guidance and wider sustainability issues. These constraints can influence the production of robust SFRA for use within the spatial planning process.

The practice guide companion to PPS25 (DCLG, 2007) identifies a number of key stakeholders, including:

- Environment Agency
- Internal Drainage Boards
- Water and Sewerage Undertakers
- Highways Authorities
- Local Planning Authorities
- Reservoir Undertakers
- Navigation Authorities

Depending on the LPA area being investigated within the SFRA, the relevance of these stakeholders needs to be assessed at the outset of the process, based on the perceived risk from potential sources of flooding. In addition, because LPA boundaries are not typically defined by river catchments, there are on occasion requirements to liaise with more than one stakeholder for similar information. This may include where SFRA span more than one Environment Agency Region (Scott Wilson, 2008a) or where more than one sewerage undertaker operates within the Local Authority Area.

The requisition of data from key stakeholders can be problematic in some instances, such as identification of individuals within large organisations that are able to provide the relevant data required to produce a robust SFRA, sensitivity of the data being provided (e.g. DG5 Register information from Water and Sewerage Undertakers) from individual organisations and the supply of data to external consultants. It is noted that although protocols such as *Working Better Together* (Environment Agency/Local Government Organisation, 2003) exist between the Environment Agency and Local Authorities, this does not extend to external advisors working on behalf of LPAs in the production of their SFRA. Where a pragmatic approach to the provision of data by stakeholders to external advisors is not taken, significant

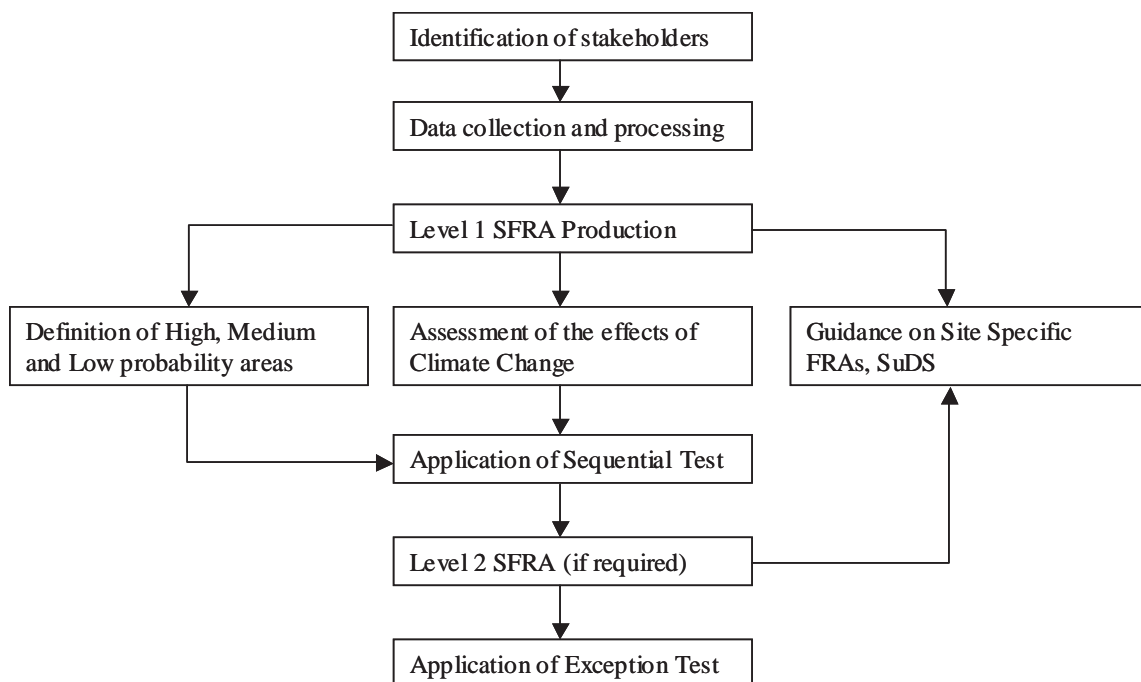


Figure 1 A simplified representation of the SFRA process.

delays may occur, thus affecting the LPA’s progression of their LDF process.

Where data exist and is provided for the production of SFRA, there are two key issues when processing these. Firstly, the quality of the data provided can be assessed in terms of relevance to the SFRA, including the information provided such as date, location, source, magnitude, duration and extent of flooding. In addition, the format in which these data are provided such as GIS, database, paper-based mapping, hard copy files and electronic files (photos, images, text) will influence the time taken to process. Secondly, the quantity of data provided will influence processing time. This is, in part, dependent upon the spatial extent of the LPA area, the actual data available for the LPA area and, again, the format in which these are provided.

Sources of data including the Flood Reconnaissance Information System (FRIS) that the Environment Agency updates and the Chronology of British Hydrological Events (<http://www.dundee.ac.uk/geography/chbe>) which provide information of varying quality. Data from these sources can range from detailed records of the flood source, location, depth extent and timing to records that provide limited details and may identify that “heavy rainfall caused flooding” but with little further information. Flood risk advisors also have to decide the relevance of flood data with respect to the spatial planning; in some instances records are provided that relate to flood events pre-dating the construction of major infrastructure such as flood defences, roads, railways, reservoirs and major conurbations, and therefore the extent of flooding may be significantly different due influences exerted by these.

Due to the potentially significant amounts of data ascertained during the data collection phase of the SFRA process and the continued updating of data sources, the issue of consistency within SFRA outputs may be problematic. One particular area is the Environment Agency Flood Zone Mapping that is revised and updated on a quarterly basis (Halcrow, 2007). The Flood Zones within PPS25 are described in Table 1.

It should be noted that the Environment Agency Flood Zone Maps in the context of SFRA only delineate

between Flood Zone 1, 2 and 3a and it is therefore the responsibility of the LPA to identify the Flood Zone 3b (Functional Floodplain). In addition, the Environment Agency Flood Maps do not account for the presence of flood defence infrastructure and therefore represent a precautionary approach. In terms of the Functional Floodplain, there are two implications with respect to its delineation. Firstly, where the LPA covers considerable spatial extents, the practical implications of delineating the Functional Floodplain for all watercourses should be evaluated against the potential requirement for development in such areas. In certain circumstances, pragmatic approaches should be sought to define the Functional Floodplain within the Level 1 SFRA. Secondly, areas benefiting from defence are not considered to be Functional Floodplain and therefore would remain as Flood Zone 3a. However, where situations exist with both river and sea flooding, delineation of the Functional Floodplain may be complicated by the protection afforded to an area by sea defence but may not be defended from the fluvial source, therefore potentially causing conflicting delineation of this Flood Zone.

With continued updating of the Environment Agency Flood Zone Maps, LPAs are challenged by time and costs when considering the Functional Floodplain in relation to their LDF process and forward planning. This is further complicated when considering the implications of climate change based on the current guidance provided in PPS25. SFRA should take into account the effects of climate change with expected increases in river flows, rainfall and sea level rise. In some instances, additional complication may arise when investigating the suitability of development vulnerability due to the lifetime of commercial and residential developments being considered as being 60 and 100 years, respectively. This is particularly relevant in coastal locations, where difference in projected sea level rise between 60 and 100 years is between 470 mm and 550 mm (dependant on location). In terms of wider sustainability issues, there may be potential conflicts with other planning policy statements such as targets for the development of previously developed land. Examples of such conflicts can be seen where LPAs have limited developable, previously

**Table 1** Flood Zone definitions as provided in PPS25

<i>Flood Zone</i>	<i>Definition</i>
Flood Zone 1 – Low Probability	Comprises of land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%)
Flood Zone 2 – Medium Probability	Comprises of land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1%-0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year
Flood Zone 3a – High Probability	Comprises of land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year
Flood Zone 3b – Functional Floodplain	Comprises of land where water has to flow or be stored in times of flood. SFRA should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes)

developed land available and where this does exist, it is within Flood Zone 3 (Scott Wilson, 2007). There may also be conflicting interests in terms of minerals and waste planning, where the spatial extent and location of mineral resources are finite and therefore it is preferable to avoid sterilisation of land to ensure longevity of the resource.

## Techniques employed within SFRAs

As identified in the previous section, there may be considerable constraints placed on the data collection process through the availability and quality of the data. This is followed by potential constraints on the application of these data within the SFRA to provide consistent and readily updateable information for the purpose of the LDF process considering other conflicting policies. The significance of the available data to provide robust SFRAs requires pragmatic approaches to be undertaken to ensure LPAs have an evidence base that passes the test of 'soundness' with in the LDF process.

The representation of the Flood Zone 3b – Functional Floodplain, represents challenges where the spatial extent of the LPA area is significant and where hydraulic modelling of watercourses across such as area is impractical. The practice guide companion to PPS25 identifies that a Level 1 SFRA should identify the Functional Floodplain 'where appropriate'. Delineation of the Functional Floodplain may also be agreed between the LPA and the Environment Agency. Scott Wilson (2007) used a pragmatic approach within the South Hams District where the study area covers approximately 900 km<sup>2</sup> and development targets are mainly fulfilled by the development of a new town, Sherford, on the Plymouth Urban Fringe. In other locations across the district, where further development has been identified to meet targets set within the Regional Planning Guidance (to be updated by the Regional Spatial Strategy that is currently in draft form), Functional Floodplain was identified using a combination of existing hydraulic model extents, historical flood outlines and liaison with the Environment Agency Development Control Engineer. In all other areas, where development is unlikely, the full extent of Flood Zone 3 is deemed to be Functional Floodplain unless demonstrated within a site-specific Flood Risk Assessment that it is outside this zone.

In terms of climate change, identification of areas where flood extents may increase due to sea level rise can be based on a simple projection of the predicted water level for the 1-in-200 year and 1-in-1000 annual probability event for the required timeframe (typically 100 years). Consideration of climate change for fluvial flooding may be available from existing hydraulic model results or by re-running these models with revised flows accounting for a 20% increase in peak discharge. Where hydraulic modelling is unavailable or the spatial extent of the LPA area prohibits detailed assessment, a proxy approach similar to that used for mapping the Functional Floodplain can be considered. This approach considers that the extent of Flood Zone 2 is used as a proxy for the extent of Flood Zone 3 inclusive of climate change. Typically, in valleys with well-defined floodplains, the spatial extent of flooding is unlikely to increase with climate change although depths and velocities are likely to

become greater.

The Environment Agency Flood Zone Maps do not represent watercourses in catchments less than 3 km<sup>2</sup>, therefore flood risk associated with these are normally classified in Flood Zone 1 unless there is local knowledge to the contrary. A number of approaches to representing Flood Zones for unmapped watercourses has been identified. Royal Haskoning (2007) have adopted a 'potential flood risk area' method which uses a combination of site visits, 5 m contour mapping and application of engineering judgement to indicate the approximate boundary of the 1-in-100 year fluvial flood event. A set of rules was used to produce the boundary, as follows:

- assume that in rural areas the floodplain extends 1 m from the watercourse;
- assume that in urban areas the floodplain extends 2 m from the watercourse; and
- at bridges and other constrictions, flow will back up, increasing the extent upstream of these structures.

Other approaches include applying a 20 m buffer either side of a watercourse in line with the statutory distance required for consultation with the Environment Agency when undertaking works adjacent to a 'main' river or applying a buffer that is consistent with Byelaws within the LPA area. These methods provide a precautionary approach, however, and where development is proposed in these locations the responsibility is then passed to the developer to provide a Flood Risk Assessment to determine a more accurate flood extent on the localised scale.

The representation of flooding from other sources such as groundwater, surface water and sewer/drainage networks is more problematic, depending on the availability of data that are of sufficient quality and temporal resolution. Recent advances both within methodologies used within SFRAs and those developed within national strategic studies are starting to provide greater representation of potential flooding from other sources. Where historical data are available on flooding from other sources, these are normally presented in an aggregated format within a GIS layer, where points or polygons can be queried to provide the user with details of historical events. As previously identified, these are dependent on the availability of data and in some cases LPAs have detailed records of flooding within their administrative areas (Scott Wilson, 2008b).

Due to the nature of groundwater flooding, it is dictated by the underlying geology and can have a strong interaction with fluvial flooding where baseflow is dominant. Jacobs (2006) undertook a study with respect to availability of existing information and knowledge on groundwater flooding, held by the Environment Agency, and the current monitoring rationale of groundwater levels in relation to flood risk management. This report identified that there is no consistent approach to the storage of data held on groundwater flooding by the Environment Agency and limited integration of current monitoring practices with flood risk management. In some instances, the Environment Agency has identified groundwater emergence zones where flooding from groundwater sources is known to occur (Scott Wilson, 2008b).

However, these do not provide information on the probability of the groundwater flood event but can be used to inform decision makers of areas liable to groundwater flooding.

In terms of urban flash flooding that is a result of heavy rainfall causing overland flow, the exceedence of drainage systems, flooding from 'lost rivers' and culverts, or a combination of the aforementioned, several studies have looked at integrated modelling approaches to improve our understanding of such flooding mechanisms (Hankin *et al.*, 2008; Smith, 2007) and their interactions. These have used a range of methods to identify flood risk areas that are potentially subject to urban flooding and include the use of buffering around historic data, topographic analysis of LiDAR data, rainfall routing across high resolution digital elevation models (DEMs) and the integration of sewer/drainage networks with overland flow networks. Results from such studies provide a good foundation to assessing historical data with model outputs and the future production of potential flood hazard maps but also identify current limitations in the application of these methods.

### Future considerations

At the strategic level, broad-scale approaches can be adopted to provide indicative extents and potential future flooding from other sources. However, with increased awareness of climate change, advances in sustainable technologies that reduce both water use within developments and management of water going off-site, either from surface water or foul water systems, these methods may actually provide betterment in their own right and therefore flood risk can be reduced. This includes positive feedback within sewer systems that are typically designed to a 1-in-30 year flow capacity. Where water efficiency measures are introduced at source, such as the reduction in wastewater and increased use of rainwater harvesting techniques, quantities of flows entering the sewer network will be reduced. This reduction may offset the projected increase in rainfall intensities and therefore the operation of sewer systems will remain at current performance.

In addition, there is also a lack of consideration for the wider catchment scale processes that operate over medium- to long-term timescales where morphological adjustment of river channels takes place in response to changes in flow regime. Increased peak flows due to wetter, milder winters and an increase in summer storms may lead to an increase in channel erosion and flood conveyance capacity. This may also be promoted due to lower flows experienced during prolonged dry periods creating areas susceptible to erosion or the progressive development of two-stage channels within floodplain systems. Again, this positive feedback within the channel evolution may reduce overbank flows and revert to a new equilibrium that may or may not lead to an increase in flood depth, velocity and extent within fluvial systems.

### Conclusions

(1) Planning policy and associated guidance for flood risk has been raised in profile with recent flooding and is

continuing to develop. Further changes are likely with the forthcoming release of the Practice Guide Companion, the consultation on Surface Water Management and the release of the Pitt Review into the Summer 2007 floods.

(2) Stakeholder engagement is an integral part of the SFRA process. However, constraints to effective data collection and processing exist. These include the identification of key individuals within stakeholder organisations, bureaucracy in terms of supply of data to external flood risk advisors working on behalf of LPA and the quantity and quality of the data provided.

(3) Although considered a 'live' document, the SFRA process is constrained where quarterly revisions of Environment Agency Flood Zone Mapping for tidal and fluvial sources make revisions to Flood Zone 3b – Functional Floodplain and Flood Zone mapping for the effects of climate change potentially time and labour intensive.

(4) Pragmatic approaches to delineation of Flood Zone 3b – Functional Floodplain and Flood Zone mapping for the effects of climate change have been identified. These provide an effective method for LPAs to assess the potential flood risk issues where development is proposed without the requirement of extensive re-mapping the above.

(5) Flooding from other sources is typically less well represented in available datasets. Potential risk of flooding from 'other sources' should be considered in proportion with the development targets of the LPA. This may be in the form of broad-scale approaches where point data on historical flooding are provided in a GIS format to allow decision-makers to query the available data. Where known issues have been identified, the application of localised modelling and analysis may be used to provide information of flood hazard from a range or combination of sources.

(6) Wider issues should also be considered when investigating flood risk and should not be limited to the current planning timeframe (typically 2026). This may consider the positive feedback mechanisms with respect to sustainable management of water resources with the effects of climate change and also the wider catchment scale changes that may occur with morphological adjustment in the medium to long term.

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