Chapter 3

Drivers of flood risk – intra-urban

Chapter 2 considered the drivers of the future risk of flooding at the fluvial and coastal level. That analysis treated urban areas as extended and featureless, except for receptors – houses, industrial and commercial property and infrastructure. The source events causing the flooding operated at a large scale, and the river and coastal defences were among the pathways of flood risk. There is, however, another set of sources and flood pathways within urban areas. These operate at different scales and are here termed ‘intra-urban’.

Firstly, we analyse the drivers of intra-urban flooding – i.e. flooding in built-up areas from the largest conurbations down to the size of villages. We describe the effects of previously identified drivers on urban flood pathways which may be on or beneath the surface. These pathways include the drainage systems owned and operated by water companies, non-main watercourses, Sustainable Urban Drainage Systems and highway drainage channels. We also consider the impact of those drivers on urban and peri-urban receptors. In particular, we consider how the interaction of those drivers affects flood risk for the timescale 2030-2100 for the four future scenarios.

3.1 Intra-urban flood mechanisms

A number of mechanisms operating at different scales can lead to surface flooding within urban areas (see Figure 3.1). These can range from overloaded building drainage – when guttering feeds into a drainage system that cannot handle the water flow – through to flooding when water backs up from rivers and estuaries into sewers that cannot convey water away from the area quickly enough. We now consider those mechanisms in some detail.

3.1.1 Pluvial flooding of houses and other premises

Flooding of houses can occur when rainwater from the roofs of buildings encounters inadequate drainage. This may be due to poor design and installation, or lack of maintenance. Maintenance is less likely to be an issue with large buildings, such as offices – flooding there would probably occur when rainfall overloads the system.

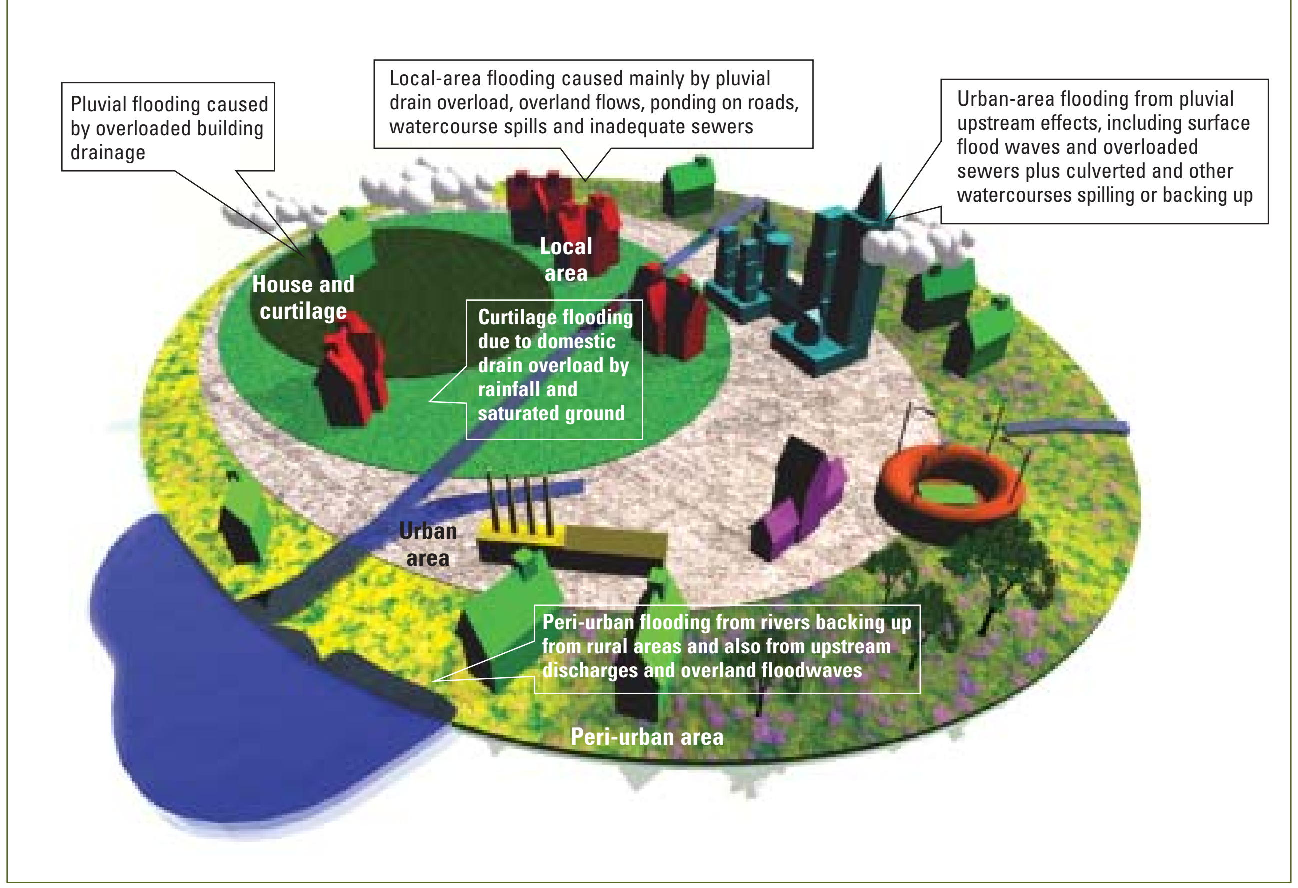
After leaving the roof, rainwater may enter local storage, local disposal such as soakaways, or discharge into a drain. Rainwater may also discharge, by accident or design, directly onto pavements or other surfaces from which it can travel downstream. Such flows can cause ponding, flooding roads and other surfaces.

Where the drainage system is on private land, it is the responsibility of the property owner. Much property drainage in the UK may well be poorly maintained, due to a lack of awareness of this obligation. Climate change is likely to increase risks from flooding caused by neglect.

Where water flows onto permeable areas, it should soak into the ground unless ground water levels are high. Climate change across much of the UK could result in longer wetter periods in winter, reducing the soil's capacity to accept water flows. Hence local flooding could increase in winter in parts of the UK.

A further problem is that stormflows could convey high sediment loads, clogging up the soil and further reducing its water-carrying capacity. This too would reduce the ground's capacity to accommodate subsequent storms. As most riparian owners do not understand the need to maintain these systems, there will be no pre-warning before flooding occurs.

Figure 3.1 **Intra-urban flooding occurs at different scales and results from many drivers. These range from inadequate rainwater drainage from domestic premises, through to seawater entering drains and preventing floodwater from leaving the area, and water arriving in urban areas as runoff from rural land**



Flooding can also happen when waves are generated over a catchment surface. Flooded areas may overflow, with floodwaves travelling onto adjacent downstream areas, causing local flooding. This effect may be more prevalent in summer than winter, as climate change could increase the intensity of summer storms in much of the UK. Runoff from these storms may bypass the formal drainage system – designed to earlier standards – moving on to flood other areas. A concern here is that where there are systems with separate drains and sewers, stormwater will mix with foul sewage. If stormwater flowing overland enters a foul-sewer, the result could be to discharge sewage over land and into property, increasing health hazards.

3.1.2 Local and wider urban-area flooding

Inadequate sewer capacity

In the main sewer network, flooding may happen when rainwater flows entering pipes exceed their carrying capacity. Pipes may then flow full and any excess backs up, resulting in a 'surcharge' of the system. Such surcharges may flood basements or the catchment surfaces from any access point to the sewer system, such as manholes.

Owners of local drainage systems generally respond to failure only when it directly affects them. Most are happy to allow failures in the local drainage to pass downstream. In Scotland, for example, there is a legal duty to 'accept any flows from upstream'. Thus a careless owner can pass responsibility for the consequences of failures in their own drainage systems to anyone unfortunate enough to live downstream. The increasing use of Sustainable Urban Drainage Systems (SUDS), where these are surface systems, should make such failures and their avoidance more apparent.

Poor performance and failure can also cause sewer flooding. The UK's sewerage operators have only an incomplete picture of the level of service and level of performance of the urban drainage systems they manage. This is one reason why attention has recently focused on the need for enhanced serviceability indicators for sewerage assets (OFWAT/EA 2001, Fenner 2002, Matos *et al.* (2003)). Of particular relevance to the intra-urban area is the need for performance measures that describe the incidence of flooding from sewers due to:

- Sewer blockages.
- Sewer collapses.
- Presence of sewer sediments.
- Failure of mechanical and electrical equipment.
- Pumping station operation.
- Inadequate hydraulic access pathways.
- Sewer pipe hydraulic inadequacy.

Currently, therefore, there is no consistent way in which we can assess the flood risk due to inadequate drainage infrastructure. The need for such performance measures is therefore a major component of future work.

Urban watercourses

In many areas, urban watercourses are now enclosed in culverts. Where there are high rainfalls and rapid upstream runoff, the water flow may exceed a culvert's capacity, leading to flooding. Many of these systems are in areas maintained by local authorities or on private land. Currently there is a lack of clarity of responsibility for flood control at the interface between riparian landowners, the local authority and the Environment Agency (in England). Although local authorities have clear powers in Scotland, problems due to local land ownership and lack of funding can lead to some confusion as to who is really responsible for flood control.

Backing up of outfalls

The capacity of sewers may also be compromised where they are connected to a river or are at the coast. Increased river depth or coastal water levels that inundate the discharge outlets of a sewer system mean that surface water can back up and hinder the system's performance. This may result in the flooding of basements and surface areas. Low-lying parts of the intra-urban area are particularly prone to this type of flooding.

3.1.3 Peri-urban flooding

Urban flooding can also occur when water flows in from the surrounding, or peri-urban land, or when water in the peri-urban region prevents water from leaving the urban area. The extent of the flooding depends on the geomorphology of the catchment. For example, steep catchments create effects that are often more severe than flooding by ponding.

Water that originates outside urban areas can cause flooding if there is no sewer system where the flow enters the area, or if the sewer system is insufficient. Inundation of the intra-urban catchment surface can also happen when flood defences fail or when water flows over or bypasses those defences. This water then overwhelms the sewer system, preventing the escape of floodwater. There can also be longer-term consequences when water floods pumping stations and other drainage equipment.

3.2 Defining the drivers inside urban areas

This report has already discussed drivers of urban flood risk at the catchment scale, where water invades urban areas from rivers and coastal waters (see Chapter 2). We now consider how this set of drivers maps onto the sources and pathways of intra-urban flooding.

The drivers of intra-urban risk have been identified, adapted to the intra-urban zone and grouped as shown in Table 3.1. Drivers which act indirectly through other drivers are shaded in grey. More detailed description of these drivers and their interactions may be found in Appendix B.

The important drivers of intra-urban flood risk as identified by this project are Precipitation, Urbanisation, Science and Technology, Catchment Runoff, the performance of the system assets and Stakeholder Behaviour. Whilst the catchment-scale analysis did not identify the role of assets and their deterioration as a driver it is, however, an extremely important driver in the intra-urban analysis.

As with the catchment-level analysis, Flood Management drivers are not considered here but are addressed in Volume II which considers possible responses to future flood risk. Public Attitudes and Expectations and Science and Technology, which are indirect drivers, are recognised as important but are not quantified in the multiplier and ranking tables. They are grey in the tables.

Table 3.1 **Driver groups in the intra-urban zone**

Driver group	Driver	SPR classification	Explanation
Climate change	Precipitation	Source	Changes in short-duration precipitation – amount, intensity, duration, location, seasonality and clustering
Runoff	Urbanisation	Pathway	A change in land management with green field and pervious surfaces covered by less-pervious materials (buildings and infrastructure) and associated new conveyance systems
	Management of Peri-Urban Rural Land	Pathway	Changes in the management of land adjacent to the urban area that influence runoff into the urban area, for example, muddy floods
Urban conveyance systems and processes	Environmental Management and Regulation	Pathway	The management of the green areas within the urban landscape, including flora and fauna
	Urban Watercourse Conveyance, Blockage and Sedimentation	Pathway	Processes associated with above-ground overland surface flow in natural watercourses and man-made systems, including performance, maintenance and operation
	Sewer Conveyance, Blockage and Sedimentation	Pathway	As above, but associated with processes that occur in below-ground drainage systems
	Impact of External Flooding on Intra-urban Drainage Systems	Pathway	Loss of conveyance and serviceability in below-ground drainage systems due to flooding from external sources
	Intra-urban Asset Deterioration	Pathway	Changes in the performance, condition and serviceability of urban drainage assets (ageing, performance wear-and-tear and rehabilitation management)

Table 3.1 **Driver groups in the intra-urban zone** *(continued)*

Driver group	Driver	SPR classification	Explanation
Human behaviour	Stakeholder Behaviour	Pathway	Mechanisms to ensure that all stakeholder interests are accommodated
	Public Attitudes and Expectations	Receptor	Taking due regard of the interests of the public, their views, beliefs, attitudes and values
Socio-economics	Buildings and Contents	Receptor	Accounting for the cost of flood damage to households
	Urban Impacts	Receptor	The potential to classify the risk of flooding in urban areas
	Infrastructure Impacts	Receptor	The impact on the performance, serviceability and economics of the drainage infrastructure due to a flood event
	Social Impacts	Receptor	The value to society of a flood event, primarily intangible, excluded by economic assessment
	Science and Technology	Receptor	Application and design of the outputs of scientific and technological research

3.3 The relative importance of the drivers

As in the other work of Phase 2 of this project, our analysis of the intra-urban drivers made the baseline assumption – that current flood-management policy and expenditure continue unchanged (Volume II considers more interventionist responses to flood risk). We assessed the impacts of drivers on the basis that source and pathway drivers alter flood risk through their impact on the probability of flooding, while receptor drivers alter flood risk through their impact on the consequences of flooding.

The evaluation of the relative importance of the drivers is conducted in two stages. Firstly, we express driver impacts as a multiplier of the flood risk in urban areas. Multipliers greater than unity indicate an increase in flood risk over the current situation, while those less than unity indicate a reduction in flood risk. We then use the driver multiplier table to rank the importance of the drivers for each of the four future scenarios – for both the 2050s and the 2080s.

3.3.1 Multipliers of flood risk for urban drivers

Table 3.2 presents the results of the assessment of flood-risk impacts. The drivers shown in this table correspond to those previously identified in Table 3.1.

Their operation (and impact) is additional to that of the catchment-level drivers in Chapter 2. Therefore, in assessing total national flood risk, the impacts of these drivers can simply be added to those due to large-scale catchment and coastal flooding.

In the case of the Environmental Management and Regulation driver and the Socioeconomic drivers we have adopted the multipliers from Chapter 2. While it is recognised that there will be some differences, we do not have the tools to define these.

It will be noted, that for the 2080s the multipliers for Precipitation vary only from 2.2 to 2.6, whereas those for the catchment zone range from 2.8 to 5.7. This is partly due to differences and inadequacies in modelling and partly due to differences in the response of existing drainage and flooding systems and mechanisms in the two zones. This is commented on in more detail in Chapter 5.

Table 3.2 **Summary results for driver impacts on flood risk: the numbers are multipliers on current flood risk (intra-urban)**

Driver type	Name	World Markets		National Enterprise		Local Stewarship		Global Sustainability	
		2050s	2080s	2050s	2080s	2050s	2080s	2050s	2080s
Climate change									
S	Precipitation	1.8	2.6	1.7	2.5	1.6	2.4	1.5	2.2
Runoff									
P	Urbanisation	1.4	2.0	1.2	1.7	1.1	1.5	1.0	1.4
P	Management of Peri-Urban Rural Land	1.2	1.4	1.0	1.0	0.9	0.7	0.9	0.8
Urban conveyance systems and processes									
P	Environmental Management and Regulation	1.0	1.0	1.0	1.0	1.4	2.8	2.0	4.0
P	Urban Watercourse Conveyance, Blockage and Sedimentation	1.6	2.0	1.1	1.2	1.0	0.9	1.0	1.1
P	Sewer Conveyance, Blockage and Sedimentation	2.0	3.0	1.6	2.0	1.0	0.9	1.0	1.1
P	Impact of External Flooding on Intra-Urban Drainage Systems	1.4	1.8	1.2	1.4	1.6	2.0	1.0	1.0
P	Intra-Urban Asset Detererioration	2.5	4.0	1.8	2.5	1.0	1.0	1.1	1.2
Human behaviour									
P	Stakeholder Behaviour	3.0	3.0	3.5	4.7	2.2	2.2	2.1	2.1
R	Public Attitudes and Expectations – known to be important but not quantified								
Socioeconomics									
R	Buildings and Contents	4.0	6.4	3.2	4.5	0.9	0.7	1.5	1.9
R	Urban Impacts	1.6	2	1.4	1.6	1.0	1.0	1.1	1.1
R	Infrastructure Impacts	4.7	9	3.2	5.2	0.9	0.7	1.5	1.5
R	Social Impacts	6.0	19.8	2.2	3.6	3.0	6.1	2.2	3.2
R	Science and Technology – known to be important but not quantified								

3.3.2 Driver ranking and driver uncertainty

We have conducted a ranking and uncertainty analysis for both 2050 and 2080.

Ranking the importance of the drivers

Tables 3.3a and 3.3b first rank the drivers for the 2050s and 2080s respectively. In common with the analysis at the catchment level, drivers are colour coded according to their level of impact and whether they act to increase or decrease flood risk.

- Red – drivers with risk multipliers greater than 2. These correspond to **High Increase drivers**.
- Yellow – drivers with multipliers between 1.2 and 2. **Medium Increase drivers**.
- Green – drivers with multipliers between 0.83 and 1.2. **Low Impact drivers**.
- Blue – drivers with multipliers between 0.5 and 0.83. **Medium decrease drivers**.

Driver uncertainty

Tables 3.4a and 3.4b present the uncertainty levels for the drivers ranked in Tables 3.3a and 3.3b.

The order of the drivers within Tables 3.4a and 3.4b corresponds to that used in Tables 3.3a and 3.3b, respectively. In this way the most important drivers are at the top. However, in Tables 3.4a and 3.4b, the colour coding now represents the uncertainty in the driver multipliers and, therefore, uncertainty in the driver ranking. In particular:

- Red – drivers with uncertainty bands wider than 3 indicate a **High Level of uncertainty**.
- Yellow – drivers with uncertainty bands between 1.5 and 3 indicate a **Medium Level of uncertainty**.
- Green – drivers with uncertainty bands narrower than 1.5 indicate a **Low Level of uncertainty**.

Table 3.3a **Driver ranking for the 2050s – urbanUU**

	World Markets 2050s	National Enterprise 2050s	Local Stewardship 2050s	Global Sustainability 2050s
1	Social Impacts	Stakeholder Behaviour	Social Impacts	Social Impacts
2	Infrastructure Impacts	Buildings and Contents	Stakeholder Behaviour	Stakeholder Behaviour
3	Buildings and Contents	Infrastructure Impacts	Impact of External Flooding on Intra-Urban Drainage Systems	Environmental Management and Regulation
4	Stakeholder Behaviour	Social Impacts	Precipitation	Buildings and Contents
5	Intra-Urban Asset Deterioration	Intra-Urban Asset Deterioration	Environmental Management and Regulation	Infrastructure Impacts
6	Sewer Conveyance, Blockage and Sedimentation	Precipitation	Urbanisation	Precipitation
7	Precipitation	Sewer Conveyance, Blockage and Sedimentation	Urban Watercourse Conveyance, Blockage and Sedimentation	Intra-Urban Asset Deterioration
8	Urban Watercourse Conveyance, Blockage and Sedimentation	Urban Impacts	Sewer Conveyance, Blockage and Sedimentation	Urban Impacts
9	Urban Impacts	Urbanisation	Intra-Urban Asset Deterioration	Urbanisation
10	Urbanisation	Impact of External Flooding on Intra-Urban Drainage Systems	Urban Impacts	Urban Watercourse Conveyance, Blockage and Sedimentation
11	Impact of External Flooding on Intra-Urban Drainage Systems	Urban Watercourse Conveyance, Blockage and Sedimentation	Management of Peri-Urban Rural Land	Sewer Conveyance, Blockage and Sedimentation
12	Management of Peri-Urban Rural Land	Management of Peri-Urban Rural Land	Buildings and Contents	Impact of External Flooding on Intra-Urban Drainage Systems
13	Environmental Management and Regulation	Environmental Ranagement and Regulation	Infrastructure Impacts	Management of Peri-Urban Rural Land
	Science and Technology – known to be Important but not quantified.			
	Public Attitudes and Expectations – known to be Important but not quantified.			

Tables 3.3b **Driver ranking for the 2080s – urban**

	World Markets 2080s	National Enterprise 2080s	Local Stewardship 2080s	Global Sustainability 2080s
1	Social Impacts	Infrastructure Impacts	Social Impacts	Environmental Management and Regulation
2	Infrastructure Impacts	Stakeholder Behaviour	Environmental Management and Regulation	Social Impacts
3	Buildings and Contents	Buildings and Contents	Stakeholder Behaviour	Precipitation
4	Intra-Urban Asset Deterioration	Social Impacts	Precipitation	Stakeholder Behaviour
5	Sewer Conveyance, Blockage and Sedimentation	Intra-Urban Asset Deterioration	Impact of External Flooding on Intra-Urban Drainage Systems	Buildings and Contents
6	Stakeholder Behaviour	Precipitation	Urbanisation	Infrastructure Impacts
7	Precipitation	Sewer Conveyance, Blockage and Sedimentation	Intra-Urban Asset Deterioration	Urbanisation
8	Urbanisation	Urbanisation	Urban impacts	Intra-Urban Asset Deterioration
9	Urban Watercourse, Conveyance, Blockage and Sedimentation	Urban Impacts	Urban Watercourse Conveyance, Blockage and Sedimentation	Urban Watercourse Conveyance, Blockage and Sedimentation
10	Urban Impacts	Impact of External Flooding on Intra-Urban Drainage Systems	Sewer Conveyance, Blockage and Sedimentation	Sewer Conveyance, Blockage and Sedimentation
11	Impact of External Flooding on Intra-Urban Drainage Systems	Urban Watercourse Conveyance, Blockage and Sedimentation	Management of Peri-Urban Rural Land	Urban Impacts
12	Management of Peri-Urban Rural Land	Management of Peri-Urban Rural Land	Buildings and Contents	Impact of external Flooding on Intra-Urban Drainage Systems
13	Environmental Management and Regulation	Environmental Management and Regulation	Infrastructure Impacts	Management of Peri-Urban Rural Land
	Science and Technology – known to be Important but not quantified.			
	Public Attitudes and Expectations – known to be Important but not quantified.			

Legend

Driver Impact Category	Risk Multiplier (M) Range	Colour Code
High Increase	M > 2	red
Medium Increase	2 > M > 1.2	yellow
Low Impact	1.2 > M < 0.83	green
Medium decrease	0.83 > M > 0.5	blue
High decrease	M < 0.5	purple

Table 3.4a **Driver uncertainty for the 2050s – urban**

	World Markets 2050s	National Enterprise 2050s	Local Stewardship 2050s	Global Sustainability 2050s
1	Social Impacts	Stakeholder Behaviour	Social Impacts	Social Impacts
2	Infrastructure Impacts	Buildings and Contents	Stakeholder Behaviour	Stakeholder Behaviour
3	Buildings and Contents	Infrastructure Impacts	Impact of External Flooding on Intra-Urban Drainage Systems	Environmental Management and Regulation
4	Stakeholder Behaviour	Social Impacts	Precipitation	Buildings and Contents
5	Intra-Urban Asset Deterioration	Intra-Urban Asset Deterioration	Environmental Management and Regulation	Infrastructure Impacts
6	Sewer Conveyance, Blockage and Sedimentation	Precipitation	Urbanisation	Precipitation
7	Precipitation	Sewer Conveyance, Blockage and Sedimentation	Urban Watercourse Conveyance, Blockage and Sedimentation	Intra-Urban Asset Deterioration
8	Urban Watercourse Conveyance, Blockage and Sedimentation	Urban Impacts	Sewer Conveyance, Blockage and Sedimentation	Urban Impacts
9	Urban Impacts	Urbanisation	Intra-Urban Asset Deterioration	Urbanisation
10	Urbanisation	Impact of External Flooding on Intra-Urban Drainage Systems	Urban Impacts	Urban Watercourse Conveyance, Blockage and Sedimentation
11	Impact of External Flooding on Intra-Urban Drainage Systems	Urban Watercourse, Conveyance, Blockage and Sedimentation	Management of Peri-Urban Rural Land	Sewer Conveyance, Blockage and Sedimentation
12	Management of Peri-Urban Rural Land	Management of Peri-Urban Rural Land	Buildings and Contents	Impact of External Flooding on Intra-Urban Drainage Systems
13	Environmental Management and Regulation	Environmental Management and Regulation	Infrastructure Impacts	Management of Peri-Urban Rural Land
	Science and Technology – known to be Important but not quantified.			
	Public Attitudes and Expectations – known to be Important but not quantified.			

Table 3.4b **Driver uncertainty for the 2080s – urban**

	World Markets 2080s	National Enterprise 2080s	Local Stewardship 2080s	Global Sustainability 2080s
1	Social Impacts	Infrastructure Impacts	Social Impacts	Environmental Management and regulation
2	Infrastructure Impacts	Stakeholder Behaviour	Environmental Management and Regulation	Social Impacts
3	Buildings and Contents	Buildings and Contents	Stakeholder Behaviour	Precipitation
4	Intra-Urban Asset Deterioration	Social Impacts	Precipitation	Stakeholder Behaviour
5	Sewer Conveyance, Blockage and Sedimentation	Intra-Urban Asset Deterioration	Impact of External Flooding on Intra-Urban Drainage Systems	Buildings and Contents
6	Stakeholder Behaviour	Precipitation	Urbanisation	Infrastructure Impacts
7	Precipitation	Sewer Conveyance, Blockage and Sedimentation	Intra-Urban Asset Deterioration	Urbanisation
8	Urbanisation	Urbanisation	Urban impacts	Intra-Urban Asset Deterioration
9	Urban Watercourse, Conveyance, Blockage and Sedimentation	Urban Impacts	Urban Watercourse Conveyance, Blockage and Sedimentation	Urban Watercourse Conveyance, Blockage and Sedimentation
10	Urban Impacts	Impact of External Flooding on Intra-Urban Drainage Systems	Sewer Conveyance, Blockage and Sedimentation	Sewer Conveyance, Blockage and Sedimentation
11	Impact of External Flooding on Intra-Urban Drainage Systems	Urban Watercourse, Conveyance, Blockage and Sedimentation	Management of Peri-Urban Rural Land	Urban Impacts
12	Management of Peri-Urban Rural Land	Management of Peri-Urban Rural Land	Buildings and Contents	Impact of External Flooding on Intra-Urban Drainage Systems
13	Environmental Management and Regulation	Environmental Management and Regulation	Infrastructure Impacts	Management of Peri-Urban Rural Land
	Science and Technology – known to be Important but not quantified.			
	Public Attitudes and Expectations – known to be Important but not quantified.			

Legend

Uncertainty Band Category	Uncertainty Band Width (B) (B = Ratio of Upper to Lower Bound Estimates of Flood Risk Impact Multiplier)	Colour Code
High	B > 3	
Medium	3 > B > 1.5	
Low	1.5 > M	

3.3.3 Commentary on the driver ranking and uncertainty analysis

Flooding of the intra-urban area is a function of many complex interactive processes and future flood risk is clearly a function of climate change, especially demonstrated by potential changes in precipitation. The greatest potential impacts are from drivers relating to precipitation, urbanisation and also in the social and economic areas.

The ranking of drivers was extremely difficult. For example, in World Markets there are high climate-change effects. But the impact as to whether urban drainage management becomes fully privatised, reverts to public ownership or remains the same has a significant impact on driver outcomes such as social equity. Similarly in respect of urbanisation, the increased impervious area raises flood risk but the adoption of new technologies as part of the urbanisation process may offset some of the problems. The key point here is that the boundary between impact and response is therefore difficult to define.

Uncertainty in the prediction of the impact of the drivers on flood risk was wide-ranging. Precipitation, stakeholder behaviour, social impact, and regulation and drainage system performance were the key uncertain parameters.

The ranking broadly follows that of the catchment and coastal drivers. Some key points to note from Tables 3.3a/3.3b and 3.4a/3.4b are:

- As would be expected there is most red, indicating high-risk drivers, in the World Market columns, decreasing as one moves across to Global Sustainability. The number of high impact drivers and their ranking is thus again very much a function of scenario.
- The socioeconomic drivers – Buildings and Contents and Infrastructure Impacts – are important under World Markets and National Enterprise, less so under the other two scenarios. Stakeholder Behaviour is important across all scenarios.
- Social impacts rank high owing to the health risks associated with the escape of sewage in intra-urban flood events, especially in the socially uneven World Markets scenarios.
- Under the Local Stewardship and Global Sustainability scenarios, Environmental Management and Regulation is important as this may constrain future flexibility in responding to flood risk.
- Precipitation ranks high under all scenarios.
- Drivers connected with the intra-urban drainage system are important. Of these, Intra-Urban Asset Deterioration and Sewer Conveyance, Blockage and Sedimentation rank highly under World Markets and National Enterprise, and are not so prominent under the other two scenarios. This reflects the more uneven management of the assets under these scenarios.
- Urbanisation and Urban Impacts are of importance, reflecting the potential dangers in how urbanisation is managed and in urban creep and development which does not take flood risk fully into account.
- The impact on the intra-urban drainage systems of high-water levels in the river and coastal waters adjacent to them and invasion by floodwaters from these sources is a medium-ranked driver under all scenarios except Global Sustainability.