4 Future changes

4.1 Introduction

The Thames CFMP will set out a policy framework for managing flood risk for the next 50-100 years. To manage the risk of flooding effectively and in a sustainable way, we need to be flexible to change and adaptable to future uncertainties.

Flood risk management is closely related to environmental conditions and engineering responses. This in turn is strongly influenced by a broad set of social, economic and political drivers. The factors which could potentially have the greatest effect are also those that we are most uncertain about. For example, the system of governance and social values. This presents us with difficult challenges for managing flood risk both now and in the future. In this chapter, we look at the characteristics and effects of these main drivers of future changes in how we manage flood risk. These are:

- urban development;
- land use change and management;
- climate change.

We have also looked at broader social and political changes and the impacts of different flood risk management responses. For example the catchment-wide effects of constructing large-scale defences and storage options.

All these drivers could potentially have quite different scales of impact. In this chapter, we look at these drivers and their effects according to their potential impact, at both a basin and policy unit scale.

In this Chapter we have presented a high level overview of the potential impact of future scenarios at a regional or basin scale. Where a particular scenario has been important in deciding what approaches to adopt to manage future flood risk and select policy, this is drawn out in more detail at a policy unit scale in Chapter Six. At any future review of the CFMP, this document would benefit from all of the detail relating to future flood risk in each individual policy statement being incorporated into this chapter. Information here could then be presented at a policy unit scale in addition to a regional or basin scale.

4.1.1 Broader drivers for change

Recent Government research into future flooding in the UK has been concluded under the Foresight Programme. Produced by the Office of Science and Technology, the project report entitled *'Future Flooding'* provides a long-term vision for the future (2030 – 2100), helping to ensure effective strategies are developed now.

The key findings of the Foresight work were:

- flood risk will increase everywhere;
- increasing national wealth will increase the value of buildings and assets at risk.

The work also highlighted some of the broader drivers in managing flood risk in the future. A number of drivers have a major effect on flood risk, but are also uncertain, for example public attitudes towards flooding. The public has expectations of protection, both for themselves and for vulnerable infrastructure and the environment.

Flood risk policy and investment decisions are now being made at a variety of different levels. Environmental directives, policies and agreements are taken at the global or European scale, whereas public expenditure decisions are largely taken by national Government. Regional Government is planning future housing allocations and local authorities are responsible for implementing this. It is possible that future decisions relating to flood risk management could be made at either a more local or global scale.

It is very difficult to reflect these broader long-term uncertainties when forming future flood risk management policies. We have accepted these as uncertainties and we will need to consider their impacts when we review this plan.

4.2 Future scenarios

4.2.1 Urban development

One of the future changes that could have an impact on flood risk is urban development, which can change the hydrological characteristics of the catchment. The Thames CFMP has assessed this through modelling scenarios, and by understanding the sensitivity of river flows to this kind of change.

Results from the BSM show that the Thames catchment is not very sensitive to urbanisation in terms of hydrological change. The catchment upstream of Teddington is essentially rural and a doubling of the urban area within the catchment has little effect on flood flows downstream of Oxford. A two-fold increase in urban area increases the 1% AEP flood flow[1] by about 1.5% at Oxford and 1% at Teddington.

The sensitivity to urbanisation was also tested within the Lee basin. A doubling[2] of the urbanised area for the entire Lee catchment upstream of the M25 increases the peak flow at Ware (see figure 2.27) by 8%. At Feildes Weir and at Waltham Abbey (M25) peak flow increases by 4%.

[1] These increases reflect the impact of urbanisation on the main river only.
[2] Doubling the FEH urban extent (URBEXT) by a factor of 2.

The results of the BSM work has shown that there is a very limited impact on flood damages from increasing the urban area, indicating that the region as a whole is relatively insensitive even to large land use changes. It should be noted however that these scenarios considered urbanisation as a source of flooding not as a receptor. They show the sensitivity of the catchment to a change that increases the speed and amount of run-off.

There is evidence to suggest that localised increases in flow could be greater. This can occur in areas where large developments are proposed and the proportional increase in urbanised areas is more than doubled. The scale of this issue will be affected by the way in which urban runoff is managed. In areas where there is effective source control, urbanisation should not increase the amount of runoff. The importance of this is highlighted in PPS25 which promotes the use of SUDS for the management of run-off and calls for appropriate surface water drainage arrangements to be demonstrated as part of the flood risk assessment for each site. This ensures that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development.

This is just one example of how development and urban regeneration can provide a crucial opportunity to manage flood risk. The location, layout and design of developments – in that order – are the most vital factors in managing flood risk. Effective ways of managing the risk (e.g. using measures such as resilience) must be incorporated into planning and design to prevent the need for future intervention. Development should manage any residual risk, taking into account the impacts of climate change.

However, development should only be permitted in areas of flood risk where there are no reasonably available sites in areas of lower flood risk and the benefits of the development outweigh the risks from flooding. Development in the floodplain places additional assets at risk, greatly increasing potential damages and reducing floodplain storage area.

Levels of future development

Four regional assemblies cover the Thames region: South East England Regional Assembly (SEERA), East of England Regional Assembly (EERA), South West Regional Assembly (SWRA) and the Greater London Authority (GLA). Figure 4.1 shows the location of the boundaries. The region is an area of intense growth, with over one million new houses planned over the next 20 years.

The housing allocations set out in these plans are:

- the draft South East Plan states that provision will be made for an annual average of 28,900 net additional dwellings between 2006 and 2026 in the South East of England. This total will be divided between the ten sub-regions. The Western Corridor and Blackwater Valley sub-region has the highest number of proposed new houses at 4,490 a year. Significant growth is also envisaged around the Gatwick area of the London Fringe with an average of 1,650 extra dwellings per annum proposed. There is likely to be a significant increase in the number of additional dwellings allocated in the final South East Plan, particularly in the proposed hubs;

- 505,000 new houses proposed between 2001-2021 in the East of England region, with an average of 26,800 extra dwellings to be built each year ;
- the draft Regional Spatial Strategy for the South West (2006-2026) makes provision for approximately 28,000 dwellings per year across the region to 2026. Nine sub-regional areas have been identified, of which only one, Swindon, is in Thames region. Here, an average of 1,700 dwellings per annum is proposed, of which 1,000 will be within the Swindon urban area. About 12,000 dwellings will be located at a strategic urban extension on the eastern side of Swindon and 3,000 on the western side of Swindon.
  - The London Plan states that the minimum target for housing provision for London is approximately 30,000 additional homes per year (1997-2016). This figure will be reviewed by 2011. All new development will be concentrated in specific areas of opportunity, regeneration and intensification

As well as housing growth, major infrastructure improvements are planned:

- redevelopment and regeneration in growth areas such as the Lower Lee Valley (including the London 2012 Olympics), Stanstead/M11 corridor and additional Priority Areas for Economic Regeneration (PAER) at Luton/Dunstable, Harlow and the Lee Valley, all identified in the EERA plan;
- major infrastructure developments, which include airport expansion in the short-term at Stansted and in the longer-term at Heathrow and Gatwick, and proposals for a large reservoir near Abingdon in Oxfordshire;
- development of the Thames Gateway, comprising over 800 km^2 of development, including 290 km^2 within the Thames tidal floodplain;
- planned expansion of towns in the upper parts of the Thames and Lee catchments; for example at Stevenage, Aylesbury, Swindon, Basingstoke and Crawley;
- planned development of brownfield sites to increase housing density. These sites are often within protected floodplain where “space” may be needed for future flood risk management.

We have concluded that the main implications of urbanisation and development on forming policy are:

- the planned growth in the south east is far less than the scenarios we have tested and quantified through our modelling. We have adequately assessed the catchment impacts of this growth in our analysis;
- the catchment wide impacts of growth on flood risk are relatively small, but can be more significant at a local scale. We have identified these main areas in our policy appraisal and highlighted the importance of source control measures to mitigate these local impacts;
- the planned growth has the potential to increase the number of social and economic receptors if it takes place in the floodplain. In many cases this will happen, and here we have highlighted some of

the messages about building and community resilience from the Government's *'Making Space for Water'* strategy;

- there may well be a conflict between policies to develop brownfield sites in floodplains and our wish to restore the natural and urban floodplain.

Figure 4.1 below shows proposed major development included in published local plans across Thames region (as of January 2004). The area covered by the GLA is shown in more detail on a separate map. It indicates the areas proposed in the London Plan for regeneration, intensification and opportunity within London.

Results from the BSM show that at a basin scale, both the Thames and Lee are not particularly sensitive to urbanisation in terms of hydrological change. However, increased urban development does have an impact at a local scale. The impact upon both components of flood risk can be reduced through appropriate layout and design of new development and promoting flood risk awareness.

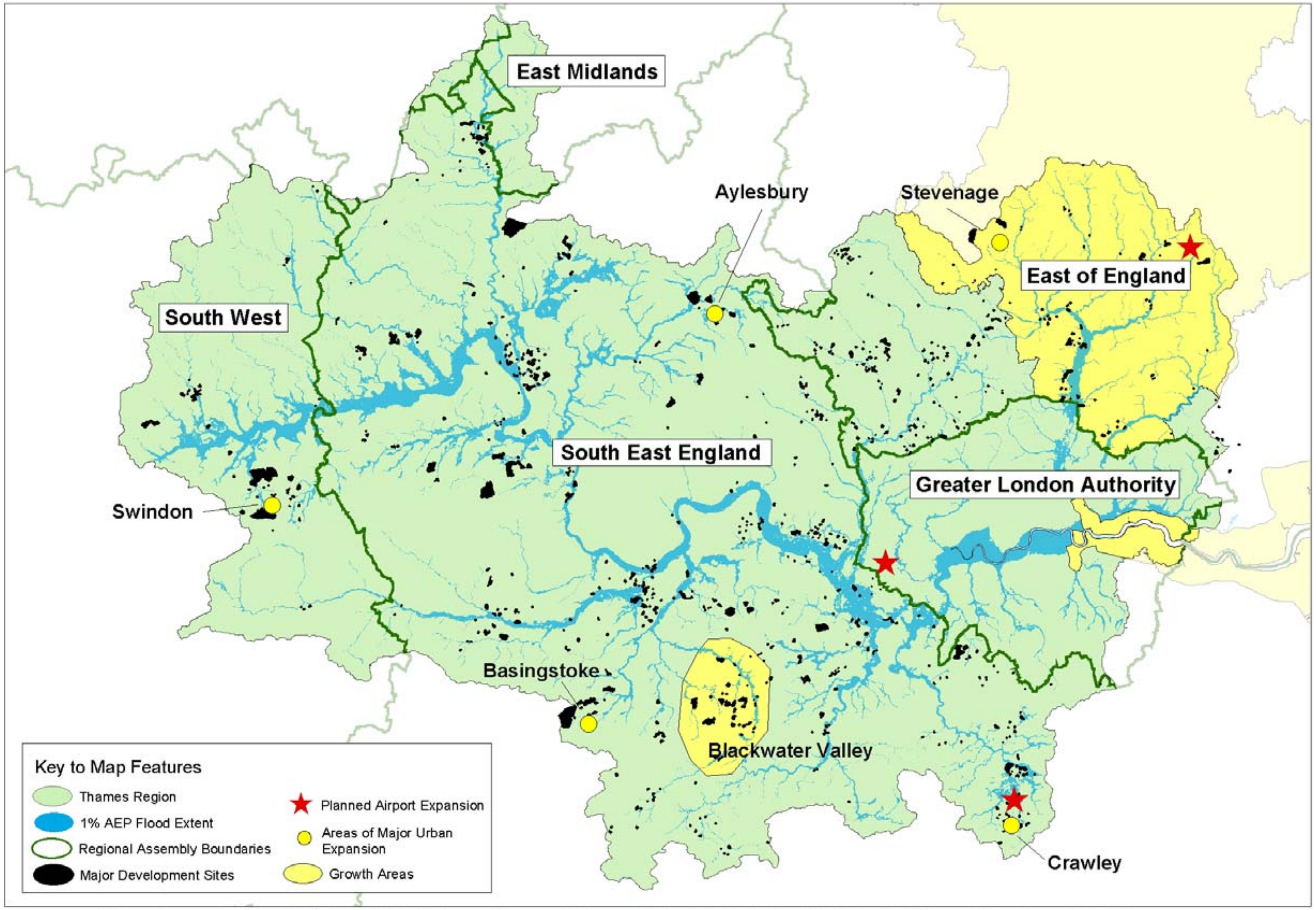

Figure 4.1 Future proposed major development in Thames region (see figure 4.2 for more detail on GLA area)

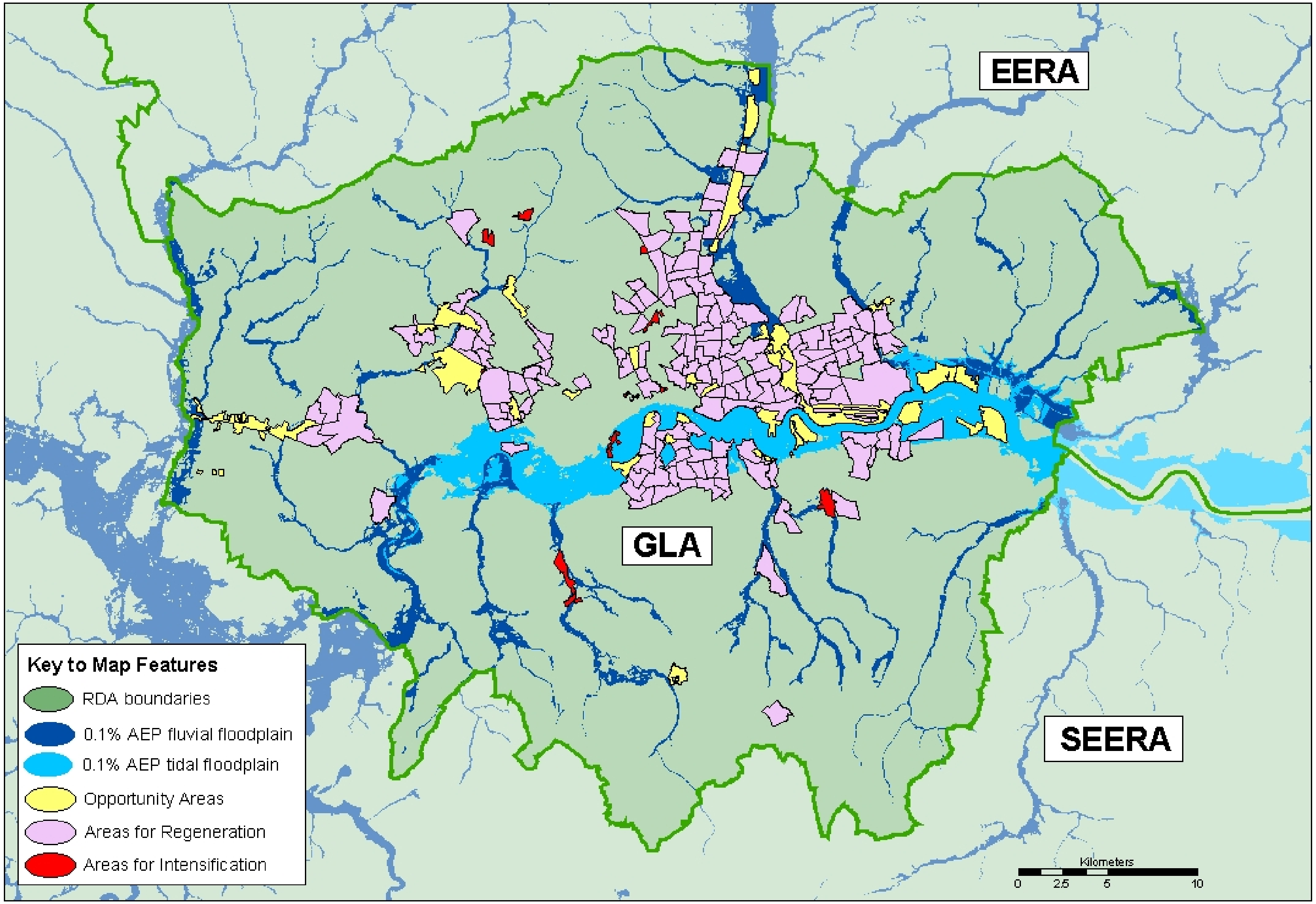

Figure 4.2 Proposed development areas identified in the London Plan

4.2.2 Rural land use change and land management

Land use and management may affect flood risk by varying a catchment's capacity to store rainfall and the passage of rainfall to streams and rivers. The relationship between catchment storage and delivery of precipitation to a watercourse is affected by how land use and management impact on the generation of runoff, i.e. the proportion of rainfall that finds its way into a given catchment's surface water system.

To assess the sensitivity to these changes the Lee broad scale model was used to investigate some generalised scenarios:

- Afforestation (immature and mature growth);

Subtract 10% of the original value from Standard Percentage Runoff (SPR). Reduce the unit hydrograph time to peak[3] (Tp) by 3 hours for immature cover. No change for mature growth.

- Improved agricultural drainage;

Reduce Tp by 2 hours for low percentage runoff (PR) soils. Increase Tp by 2 hours for high PR soils.

- Agricultural intensification

Increase SPR by a factor of 1.15.

It should be noted that there is considerable scientific uncertainty about the net effects of land use changes on flood risk. The changes to Tp and SPR, although they have an empirical basis, are highly generalised. This follows the guidance given in the Defra R&D Project FD2114[4].

Land use change

This is defined as the change from one specific land use to another, for example from arable land to woodland.

The results from the BSM testing of the afforestation scenarios are based on the assumption that where there is a change to mature and immature afforestation, a generalised reduction in runoff of 10% would occur. In addition, the 'time to peak' was reduced by 3 hours for areas of immature afforestation within the areas tested. The effect of afforestation (mature growth) reduces the peak flows by up to 11%. Afforestation (immature growth) reduces peak flow by up to 4% and the timing of the peak flow is approximately 2-5 hours earlier.

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[3] The time, in hours, between the centroid of a rainfall event and the peak of the resulting flood wave at a particular location. A short time to peak generally indicates a 'flashy' catchment where floods occur rapidly after rainfall. Longer times to peak are characteristic of lowland catchments or those with attenuating water bodies.

[4] Report FD2114/PR2: "Review of Impacts of rural land use and management on flood generation: Short–term improvements to the FEH rainfall-runoff model: User manual" (November 2004).

Land management change

This is defined as a change in land management techniques within one specific land use type. For example changes in the farming practices of arable land, or a change in drainage configuration within woodland. The Lee BSM tested improved agricultural drainage and agricultural intensification as detailed in the National CFMP Guidelines. The effects of all the scenarios on flows are show in Figure 4.3.

The scenario of improved agricultural drainage assumes a reduction in time to peak of 2 hours whilst the scenario of agricultural intensification assumes an increase in runoff of 15%.

Improved agricultural drainage results in an approximate increase of peak flows by up to 7%, with the timing of the peak flow occurring approximately 2 hours earlier.

Agricultural intensification results in a similar shaped hydrograph and increases peak flow by up to approximately 17%.

While these could be considered to be notable impacts, they are the result of significant widespread changes across the basin. In addition these impacts are on the 1%AEP flood event.

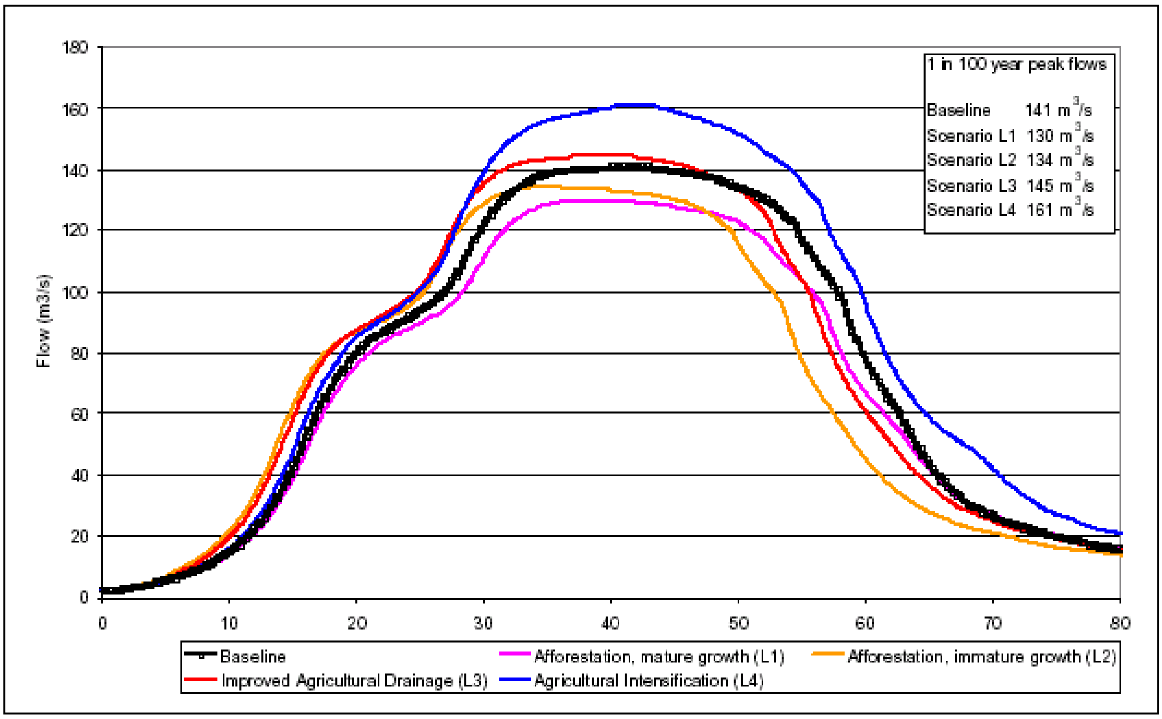

Figure 4.3 Impact of land use and land management change on 1% AEP flood event peak flows at Feildes weir on the Lee catchment

Large-scale change in land use is perceived to have significant effects on rates of runoff within any given catchment. The magnitude and specific characteristics of such effects are dependent upon the nature of land use change. With regard to land management, there has been wide-ranging research work indicating that there is some potential for runoff control through measures such as directional ploughing on slopes and changes to cropping patterns.

The impacts that land use and management change will have on a given catchment cannot be defined with any degree of certainty and have not been proven on a catchment-wide scale or for extreme design events[5]. Targeted changes may have the potential to provide benefits for local and low return period events, but will be dependent on specific catchment characteristics. However, it is difficult to predict how large scale land use or management change will affect floods. O'Connell *et al* (2004)[6] conclude that:

"*There is only very limited evidence that local changes in runoff are transferred to the surface water network and propagate downstream. This may be because there have been very few studies in which evidence has been sought, or because such studies (of, for example, afforestation or land drainage) have produced inconsistent or uncertain conclusions. However, in comparison with natural climatic variability, it would appear that land use management effects are of second order importance*."

Future policy changes such as 'cross compliance' under CAP (Common Agriculture Policy) Reform and the new agri-environmental scheme, Environmental Stewardship, may have the potential, in part to, address the impacts of modern land use management.

The whole-catchment approach to land use and land management planning was advocated in the report of the Policy Commission on the Future of Food and Farming (The Curry Commission). In particular, the Commission recommended that:

"…future environmental schemes and, where appropriate, woodland schemes should include water management as an option for support…the Government should ensure that land management responses to flooding are eligible for funding from flood management budgets alongside more traditional methods of flood defence…aided by a rapid shift to whole-catchment planning and away from the current system. The farming industry should look to embrace water management as a viable 'alternative crop'."

[5] Clegg, M. (2005), Consideration of the Feasibility of Land Use & Management Change Options in the Development of the Oxford Flood Risk Management Study and Thames Region CFMP.
[6] O'Connell *et al.* (2004), Defra Research and Development Technical Report FD2114. Review of the impacts of rural land use and management of flood generation. Defra, London.

Using MDSF we modelled the impact of a 10% reduction in flows across the whole Region. This sensitivity test showed that we might expect a 12% reduction in the number of properties affected and a 20% reduction in the expected AAD. However it is impossible that all of this reduction could be achieved within Thames region because:

- In the lower parts of the basins, land is already very heavily managed (the heavily urbanised parts of the region account for some 70% of the properties in the region). Therefore the opportunities for achieving flood risk improvements through land use and management change in these areas are extremely limited.
- It is very unlikely that we can achieve such comprehensive land management changes across the upper parts of the region.

Therefore we would estimate that at best it might be possible to achieve 10% of the impact shown by the modelling in the upper rural parts of the region, and realistically land management is very unlikely to provide more than a 1% reduction in properties affected and damages across the region. Therefore in terms of region wide approaches to flood risk management land management is unlikely to play a significant role.

However, there is potential for more localised land use and management change, especially in the upper parts of both the Thames and Lee basins. This is based on current land cover type and whether they can incorporate new management measures (i.e. seasonal working, contour ploughing, buffer strips, hedgerow planting or optimal drainage configuration) that reduce susceptibility to runoff generation processes[7]. These changes could provide a range of benefits at a local level for biodiversity, soil conservation and, potentially, flood risk management (lower order events only). A recent Making Space for Water study[8] on the River Ripon in Yorkshire (Ripon Multi-objective Pilot Study) concluded that, *"although modelling results have indicated that changing land management practices may not provide significant benefits in terms of reducing the peak flows of extreme floods, it is important to note that land management may offer the potential to improve flood warning times and therefore reduce flood damages."*

The local opportunities in the upper parts of the catchments will be considered in more detail in Chapters 5 and 6.

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[7] Clegg, M. (2005), Consideration of the Feasibility of Land Use & Management Change Options in the Development of the Oxford Flood Risk Management Study and Thames Region CFMP

[8] Halcrow Group Limited (2008), The Role of Land Use and Land Management in Delivering Flood Risk Management (Final Report).

4.2.3 Climate change

Climate change is potentially the most significant factor that will increase flood risk. The United Kingdom Climate Impacts Programme (UKCIP) scenarios for 2050 suggest that flood event peak flows may vary from a 30% reduction to a 20% increase. Climate change will bring an increase in the frequency and magnitude of winter and spring flooding and also more frequent summer thunderstorms. As well as increasing the frequency of flooding, climate change will lead to an increase in the depth of flooding and floodplain extent. This will put more and different assets at risk, therefore increasing the consequences. The latest guidance, given by Defra, advises that increases of up to 20% in peak flows, for a given flood event, could be experienced by 2050. The graph below (figure 4.4) illustrates the predicted changes in flow at Oxford for a 1% AEP flood event, produced as part of the Thames BSM work.

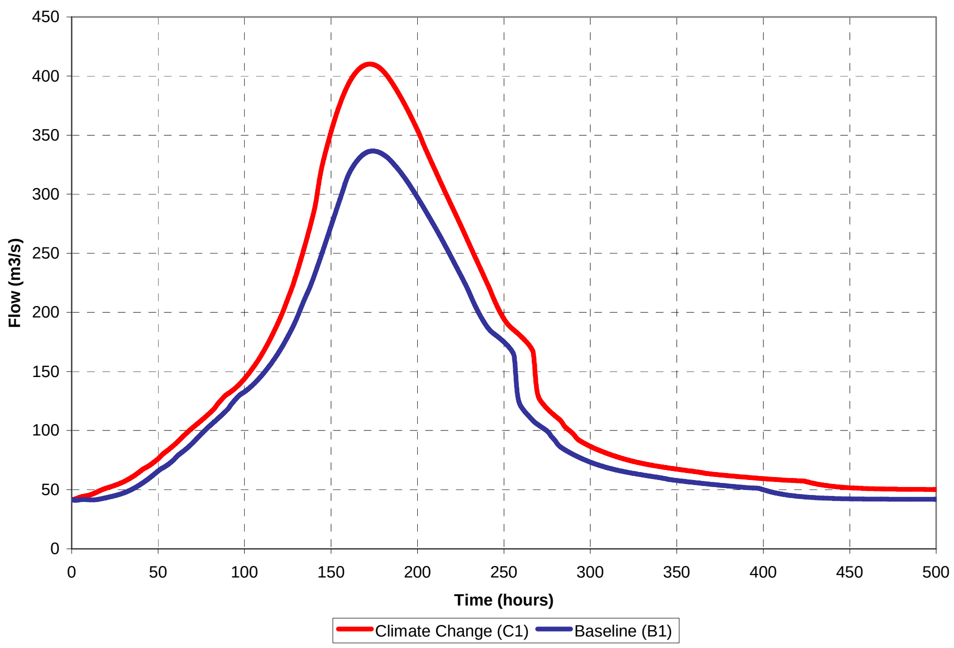


Figure 4.4 Comparison of the 1% AEP flood event flows at Oxford

Using the MDSF software, we assessed the effects of climate change on the CFMP indicators. This included analysis of flood extents, depths, flooded properties and damages. We were able to calculate AAD for the Thames and Lee basins using the 20%, 10%, 4%, 1% and 0.5% AEP results. For the London rivers, AAD was calculated using the 20%, 5% and 1% AEP results[9]. These results are looked at in detail in section 4.3.

[9] Detailed model data for climate change scenarios was not available for the Beverley Brook within the London rivers area. The baseline damages and property numbers have been adjusted for this, in order to allow a relative comparison between scenarios.

The results of the sensitivity testing have provided information on the likely effects of different potential changes within the Thames CFMP area. They show that at a regional, river basin and even catchment scale, climate change has the greatest significance for future levels of flood risk due to the large increases in fluvial flows.

At a local scale, however, inappropriate development can be the most significant factor in increasing flood risk, by placing more people and economic assets in the floodplain. There are mechanisms for managing this kind of risk, for example the thorough application of PPS25, detailed strategic flood risk assessments (SFRAs) or, in some cases, through joint actions identified in strategy studies (for example in the Upper Mole catchment). If existing legislation is applied effectively, the overall risk of flooding should not increase as a result of this driver. In some areas, we may need to highlight this message through our policies.

The impacts that land use and management change will have on a given catchment cannot be defined with any degree of certainty and it is difficult to predict how large scale land use or management change will affect floods. Results from the BSM also show that at a basin scale, both the Thames and Lee are not particularly sensitive to urbanisation in terms of hydrological change.

The assessment of future flood risk in section 4.3 is therefore based on the potential impact of climate change. In our policy appraisal, we identify areas that are at particular risk from the localised impacts of urbanisation and where targeted changes in land use and management may have the potential to provide benefits for local and low return period events.

4.3 Assessment of the future flood risk

Similar to the analysis work presented in section 3.3 Consequences of Flooding, we will now look at the increase in the number of social, economic and environmental assets at risk, as a result of future climate change. The majority of this data was derived using MDSF and coverage varies for each policy unit. Please refer to Table 3.2 for further detail. How climate change will actually change the hydrology of our catchments is uncertain. At present, the expert view suggests that in the Thames catchment a 20% increase in flow over-estimates the potential effects.

The first part of this section presents the potential changes in flood extents and water depths for given magnitudes of flood events. As a result of larger flood extents and deeper depths of flood water, additional assets will be at risk and levels of risk will also increase. This will affect social, economic and environmental assets.

The results presented here are for fluvial flood risk only, however we recognise that there are also future risks associated with surface water and groundwater flooding. We have been unable to quantify this risk due to the fact that detailed information and modelling is not currently available. The Foresight Report: Executive Summary states that 'The numbers of properties at high risk (10% AEP flood) of localised flooding could typically increase four-fold under the four future scenarios'[10]. Drainage systems are likely to reach their capacity more frequently and the incidence of flooding will rapidly increase.

The Pitt Review and associated recommendations will draw attention to the importance of other sources of flooding and guide us as to future work in these areas.

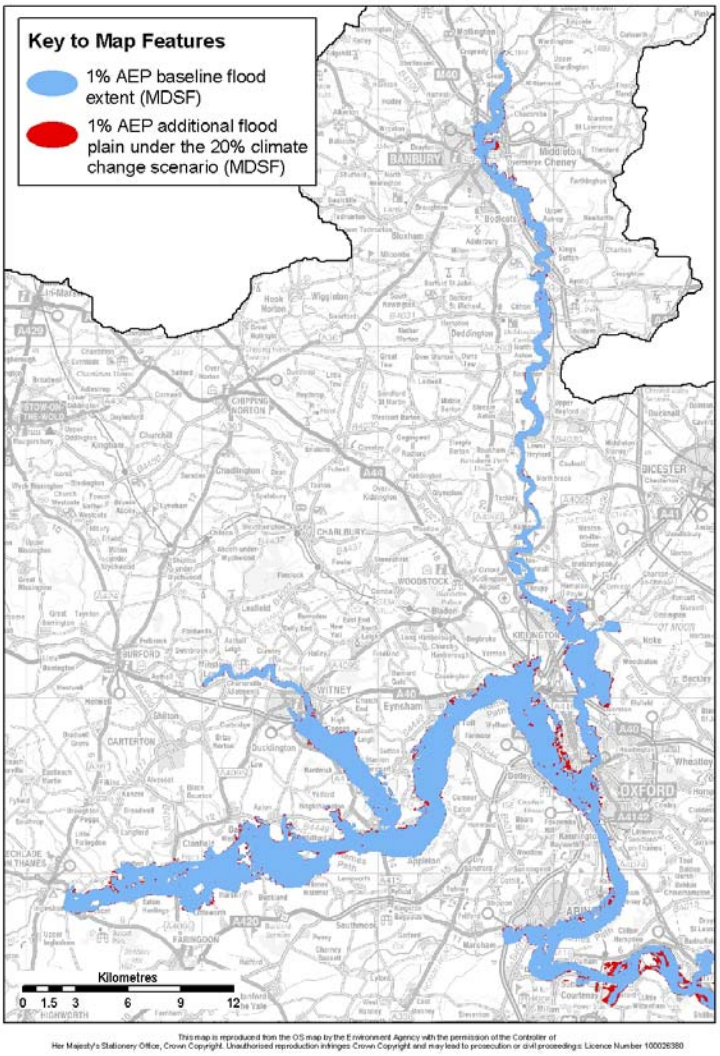
The impact of climate change on groundwater flooding will relate to the balance between changes in precipitation and increases in temperature. There are already large areas of Thames region susceptible to groundwater flooding (chalk aquifers and underlying gravels in floodplain areas) however it is uncertain whether the level of risk will increase.

Changes in flood extent

Climate change is predicted to increase both the probability of flooding (due to changes in weather patterns and increases in river flows) and the consequences. An increase in flows will lead to an increase in the area of flood extents putting more people at risk and will also increase flood depths, posing a greater risk to life and causing greater economic damages. The following results were all produced using the MDSF software.

Under the climate change scenario (20% increase in flow), the 1% AEP flood extent increases in area by 12% in both the Thames basin and the London rivers. For the Lee, the increase is 19%. The places where there will be the greatest increase in people at risk due to climate change tend to be in areas where there are wide and flat floodplains. These include the Oxford, Sandford to Cookham, Windsor and Maidenhead, Lower Thames and Lower Lee policy units. Due to the topography in these areas, there is the potential for a large increase in the area of the flood extent for an event of a given magnitude.

[10] Office of Science and Technology (2003), 'Foresight Flood and Coastal Defence Project: Executive Summary'. Future risks of flooding were analysed for four different future scenarios – they embody different approaches to governance (centralised versus localised) and different values held by society (consumerist versus community).



Figures 4.5 to 4.15 show the increase in area of these new flood extents across the Thames CFMP area for a 1% AEP flood event. Coverage is limited to the MDSF modelling extent. An example for the 10% AEP event in the Lower Thames is provided in Figure 4.16 for comparison. To illustrate the significance of climate change compared to urbanisation, the future extent for this scenario for the 1% AEP event is provided in Figure 4.17.

Figure 4.5 Increase in the 1% AEP flood extent in the Upper Thames area as a result of climate change

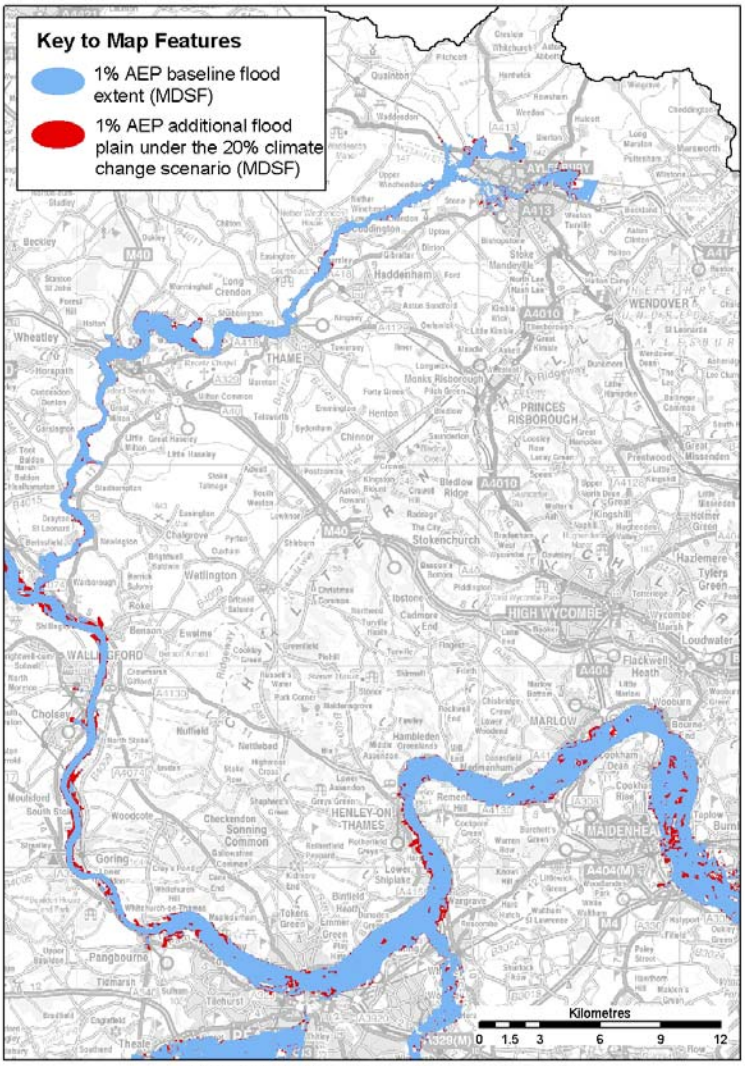
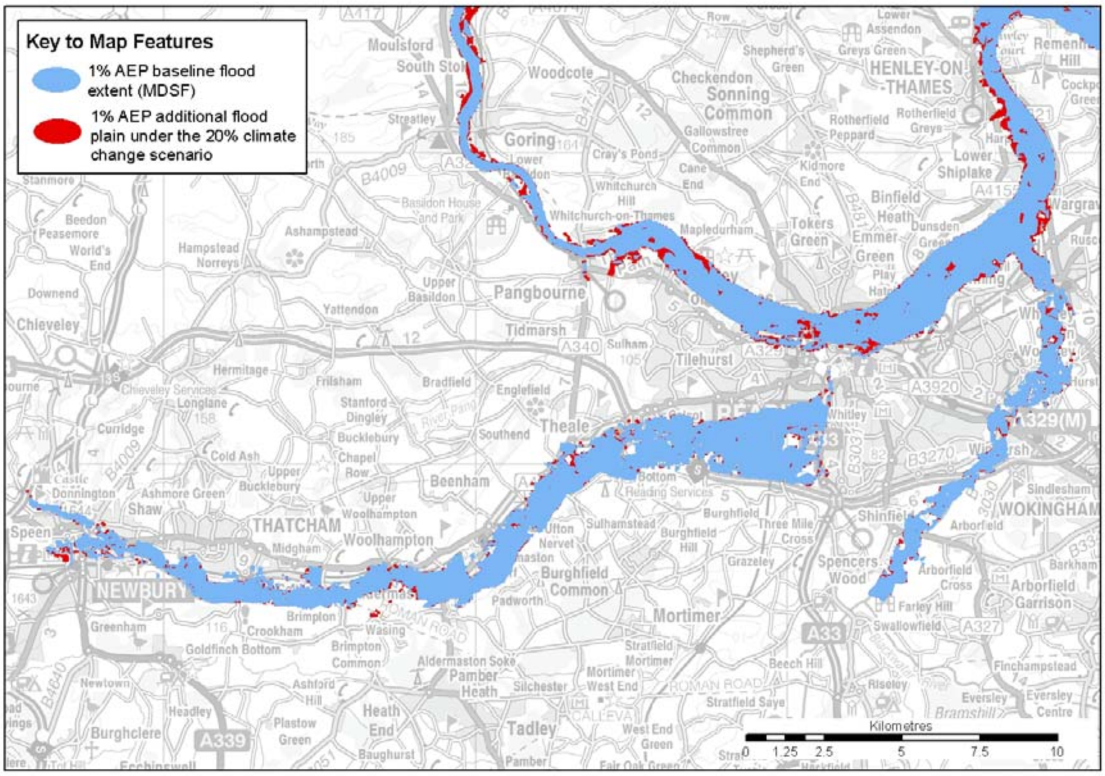


Figure 4.6 Increase in the 1% AEP flood extent in the Thame catchment and the Thames: Sandford to Cookham as a result of climate change

Figure 4.7 Increase in the 1% AEP flood extent in the Kennet and Loddon catchments as a result of climate change



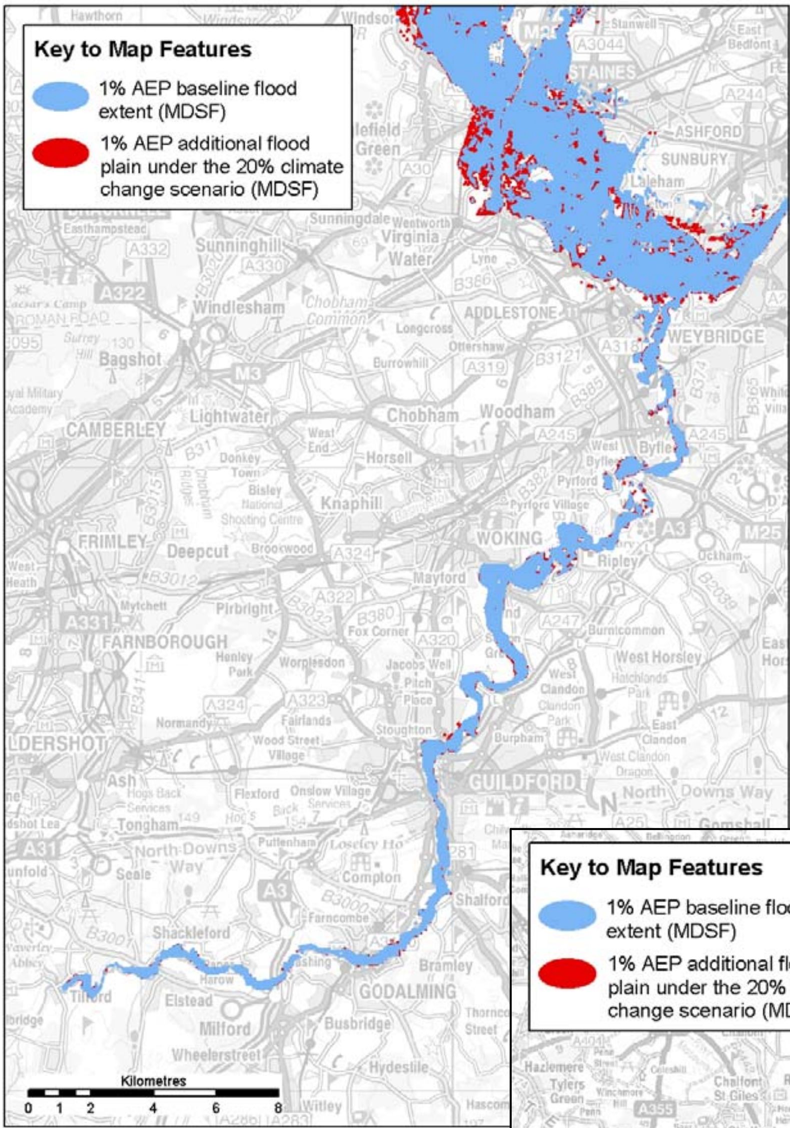


Figure 4.8 Increase in the 1% AEP flood extent in the Wey catchment as a result of climate change

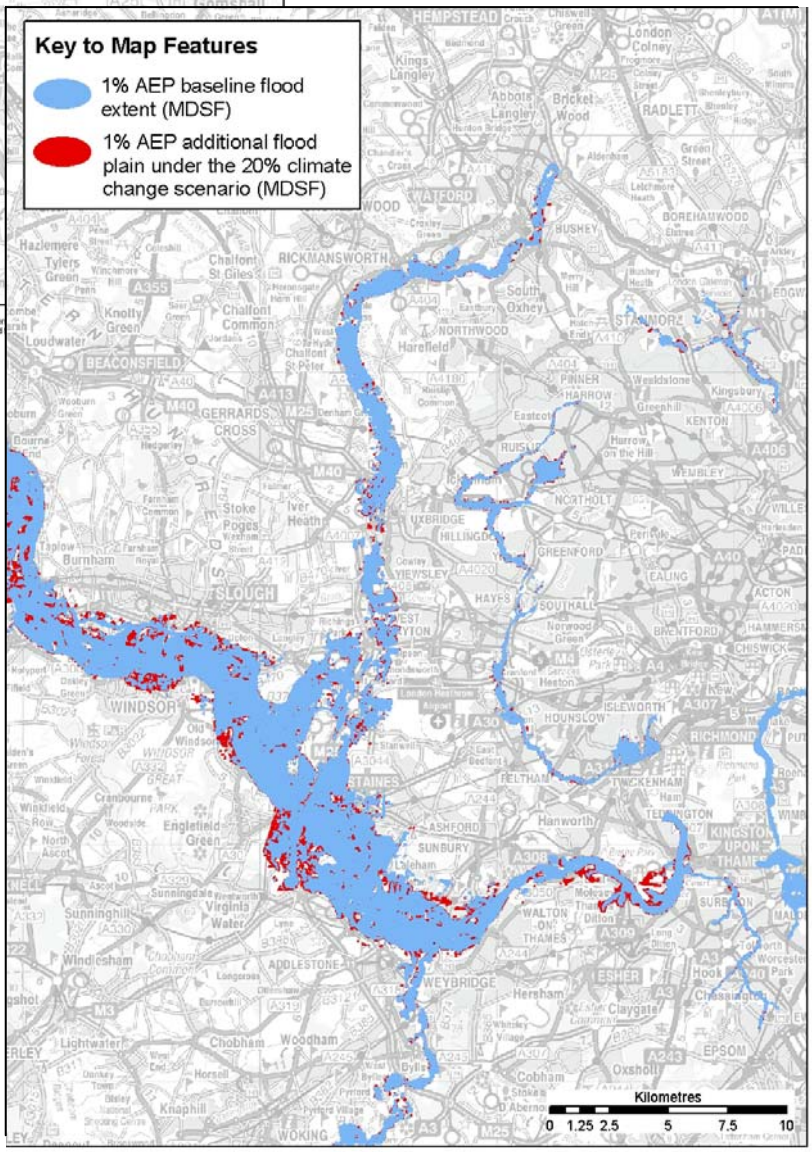


Figure 4.9 Increase in the 1% AEP flood extent in the Lower Thames, Colne, Brent and Crane catchments as a result of climate change

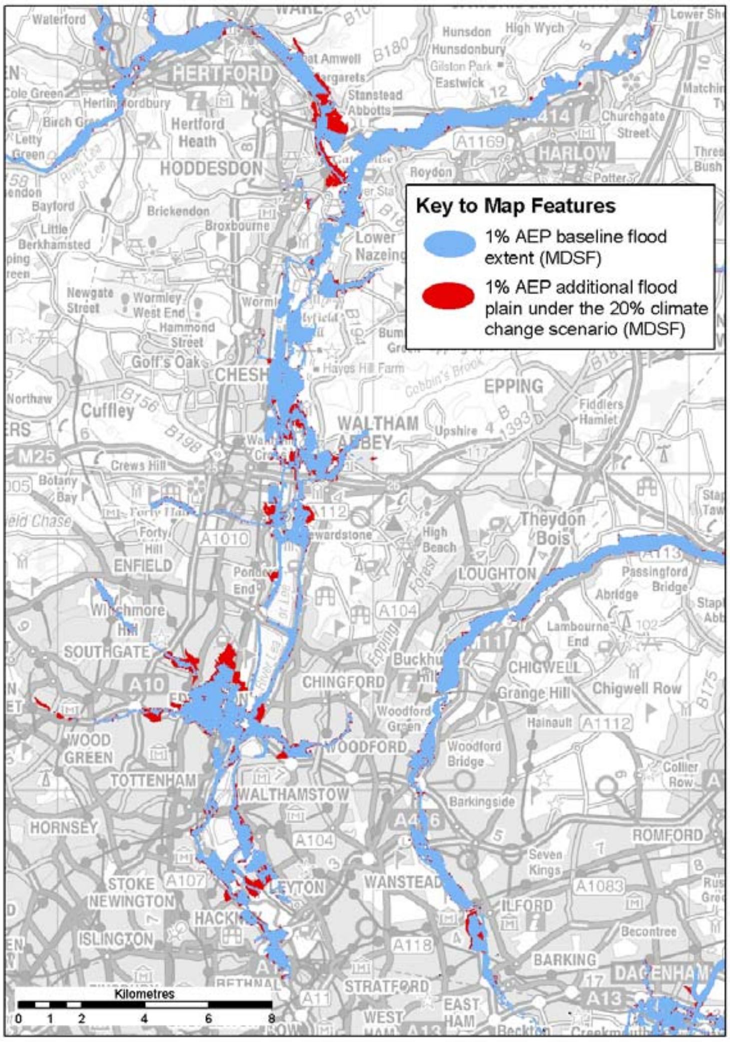


Figure 4.10 Increase in the 1% AEP flood extent in the Lower Lee and Lower and Middle Roding as a result of climate change

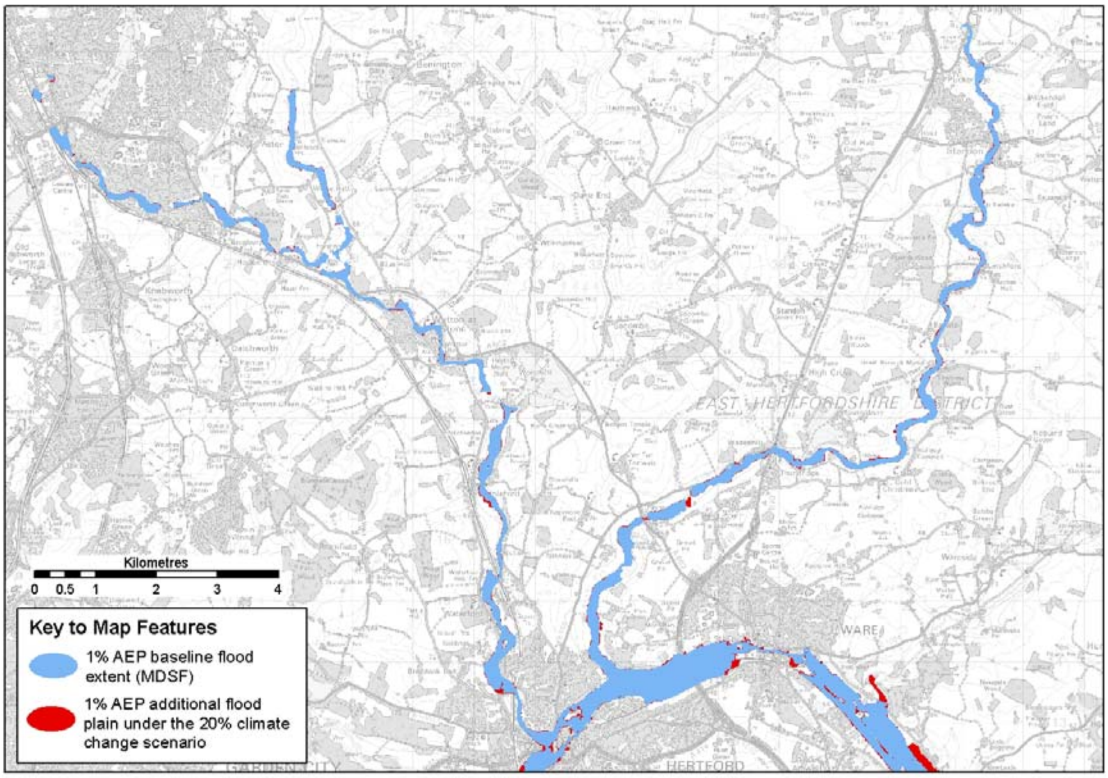


Figure 4.11 Increase in the 1% AEP flood extent in the Middle Lee as a result of climate change

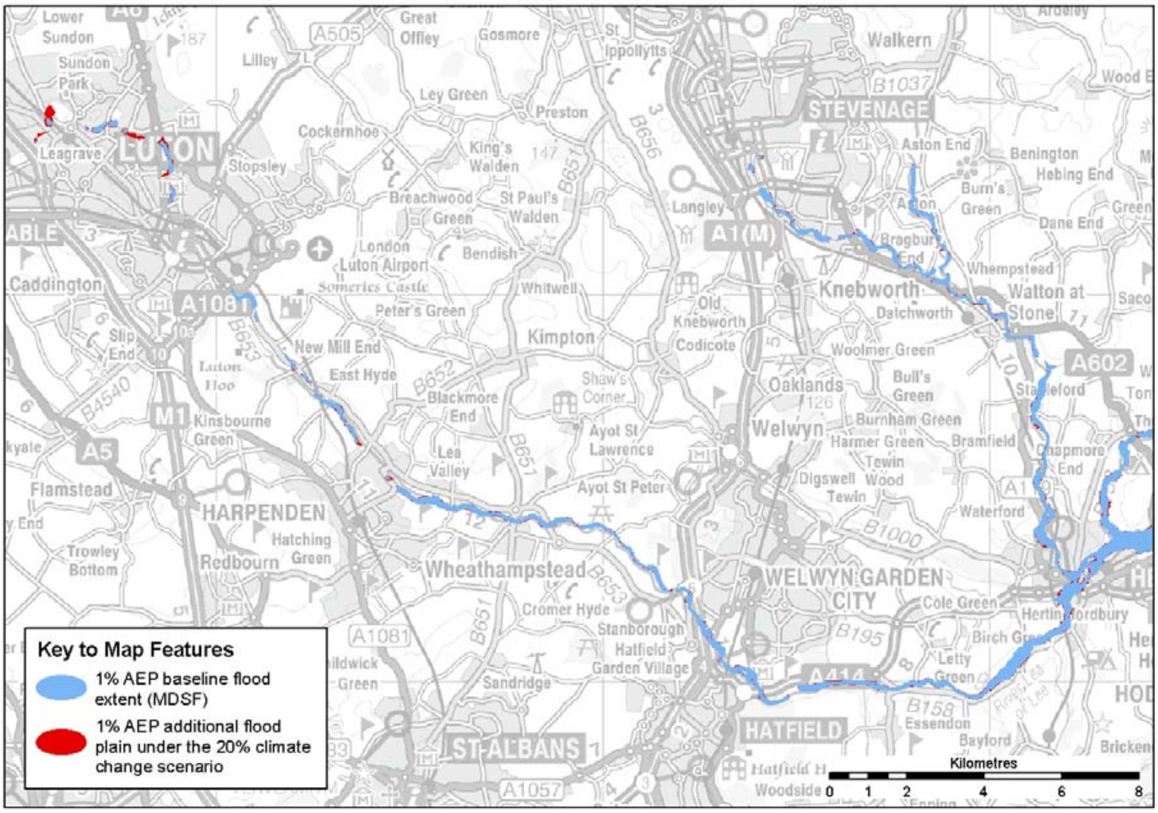


Figure 4.12 Increase in the 1% AEP flood extent in Upper Lee as a result of climate change

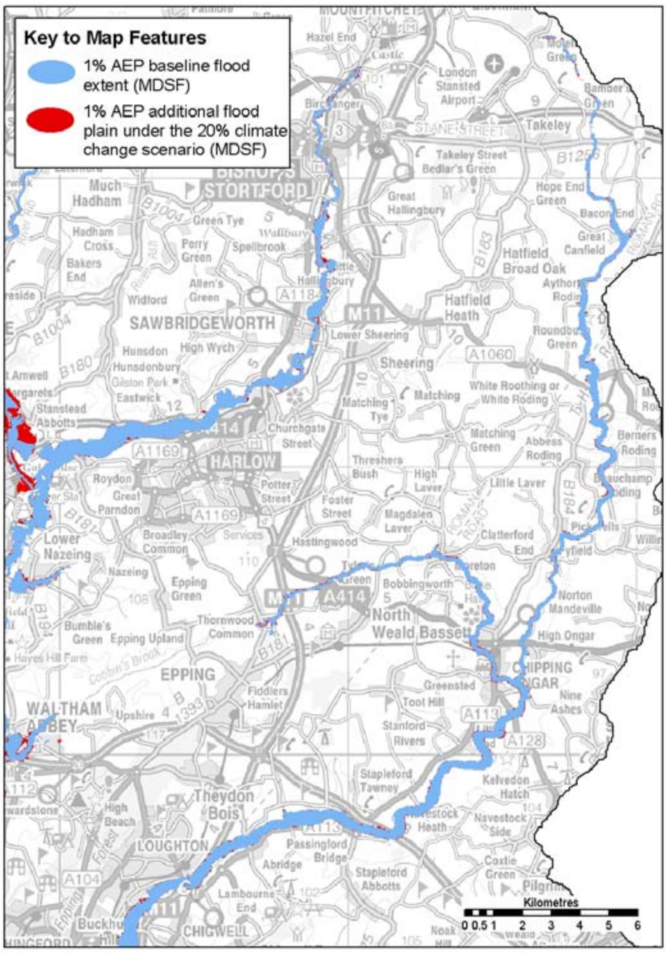


Figure 4.13 Increase in the 1% AEP flood extent in the Upper Roding and Stort catchments as a result of climate change

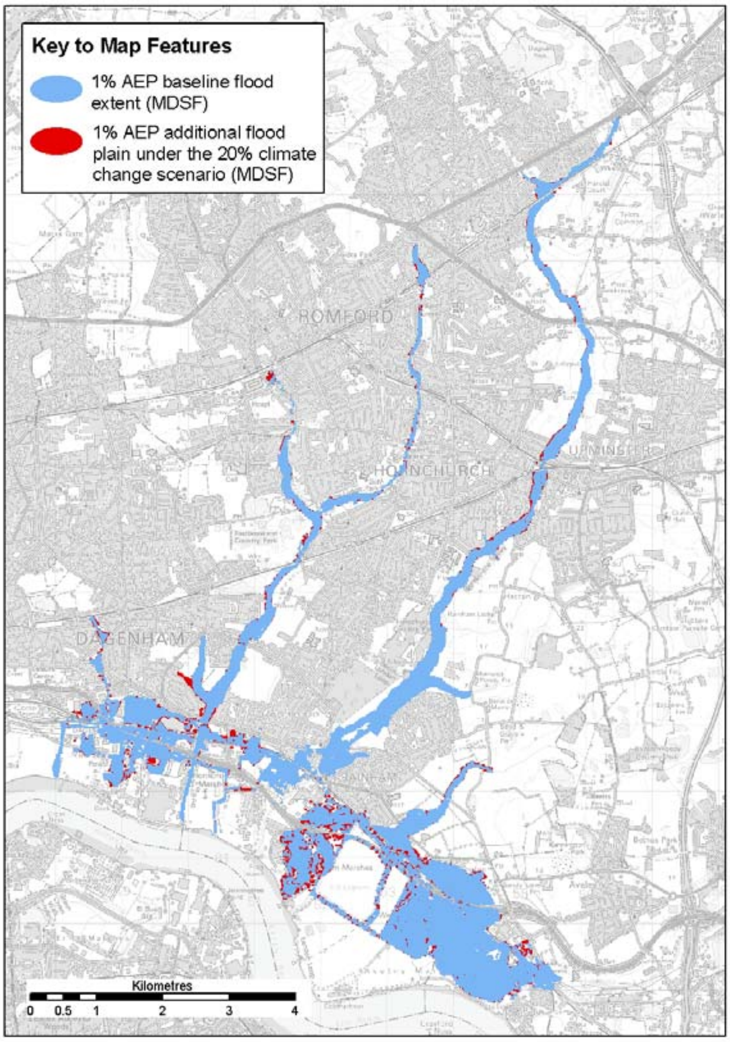


Figure 4.14 Increase in the 1% AEP flood extent in the Beam and Ingrebourne catchments as a result of climate change

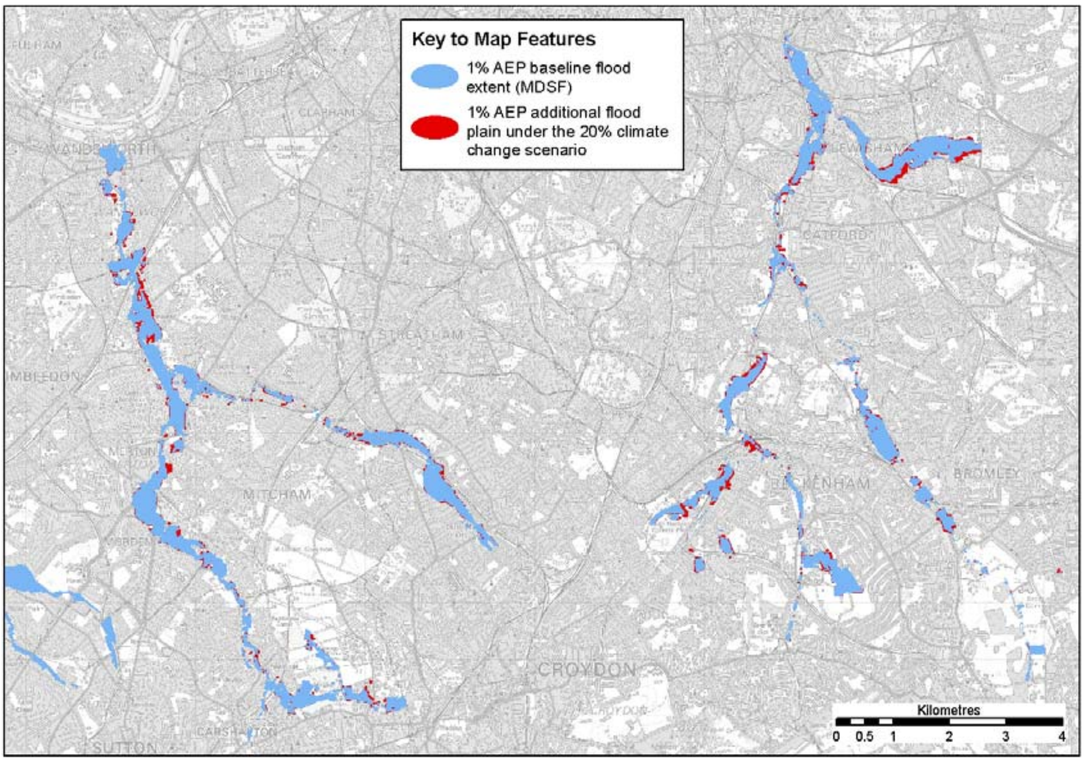


Figure 4.15 Increase in the 1% AEP flood extent in the Wandle and Ravensbourne catchments as a result of climate change

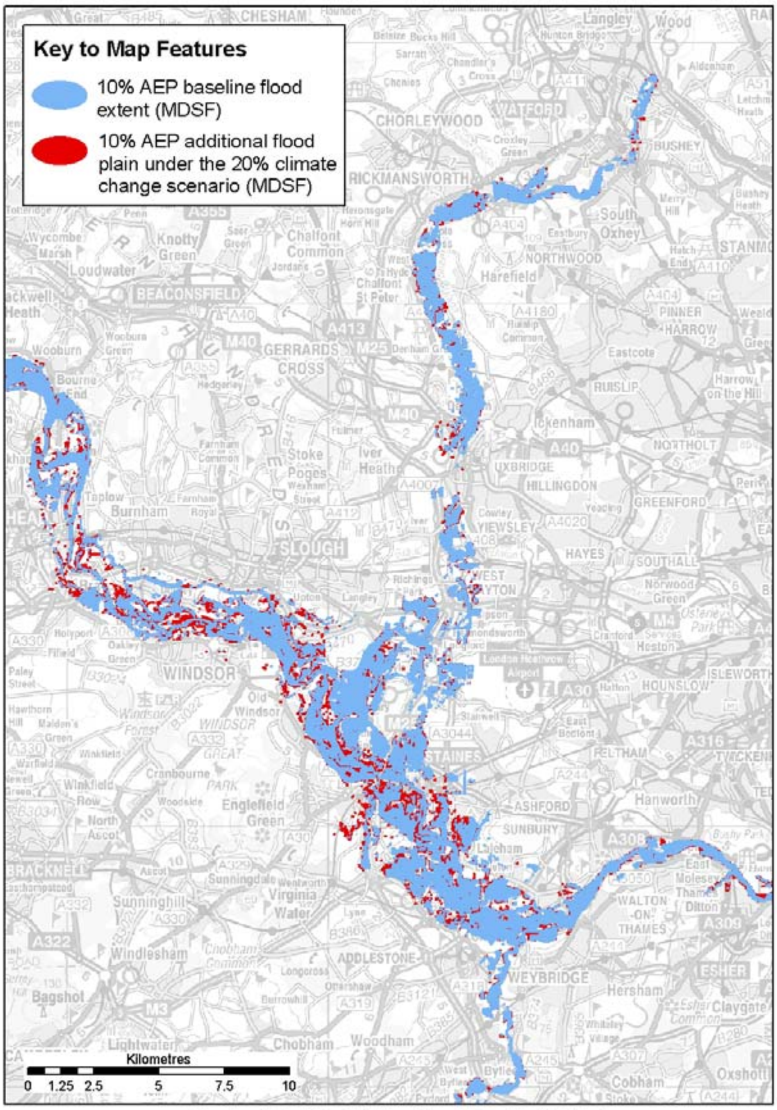


Figure 4.16 Increase in the 10% AEP flood extent in the Lower Thames as a result of climate change

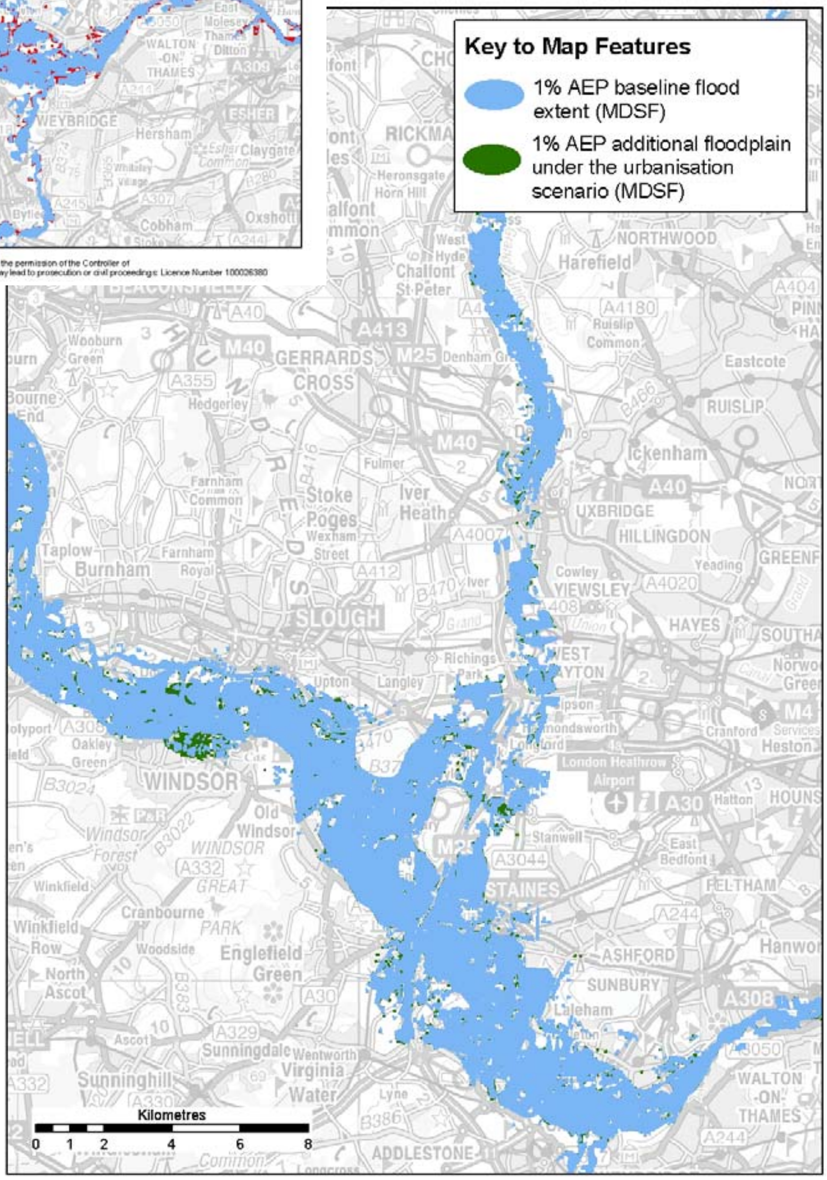


Figure 4.17 Increase in the 1% AEP flood extent in the Lower Thames as a result of urbanisation (a doubling of the urban extent within the policy unit)

Changes in flood water depth

In certain parts of the region, the increases in flood extent are not very large but there are noticeable increases in the depth of flood water. For example in the upstream reaches of the Cherwell, Lee and Wey, where the channels are narrower, with a steeper topography. However, there are fewer properties at risk in these areas.

The average flood depth for the 1% AEP flood event in the Thames basin increases from 0.09 m to 0.31 m under a 20% climate change scenario. In the Lee basin, the increase in depth is from 0.23 m to 0.33 m. It is a similar change for the London rivers (increase from 0.15 m to 0.25 m). However, these changes in depth are more relevant at the policy unit level. Examples from major urban areas are shown in the following maps (Figure 4.19 to 4.22). The overview in Figure 4.18 shows the locations of Figures 4.19 to 4.22.

A more detailed breakdown of the location of the properties at risk from an increase in flood depth is presented in the ‘flood risk to property and social economic development’ section.

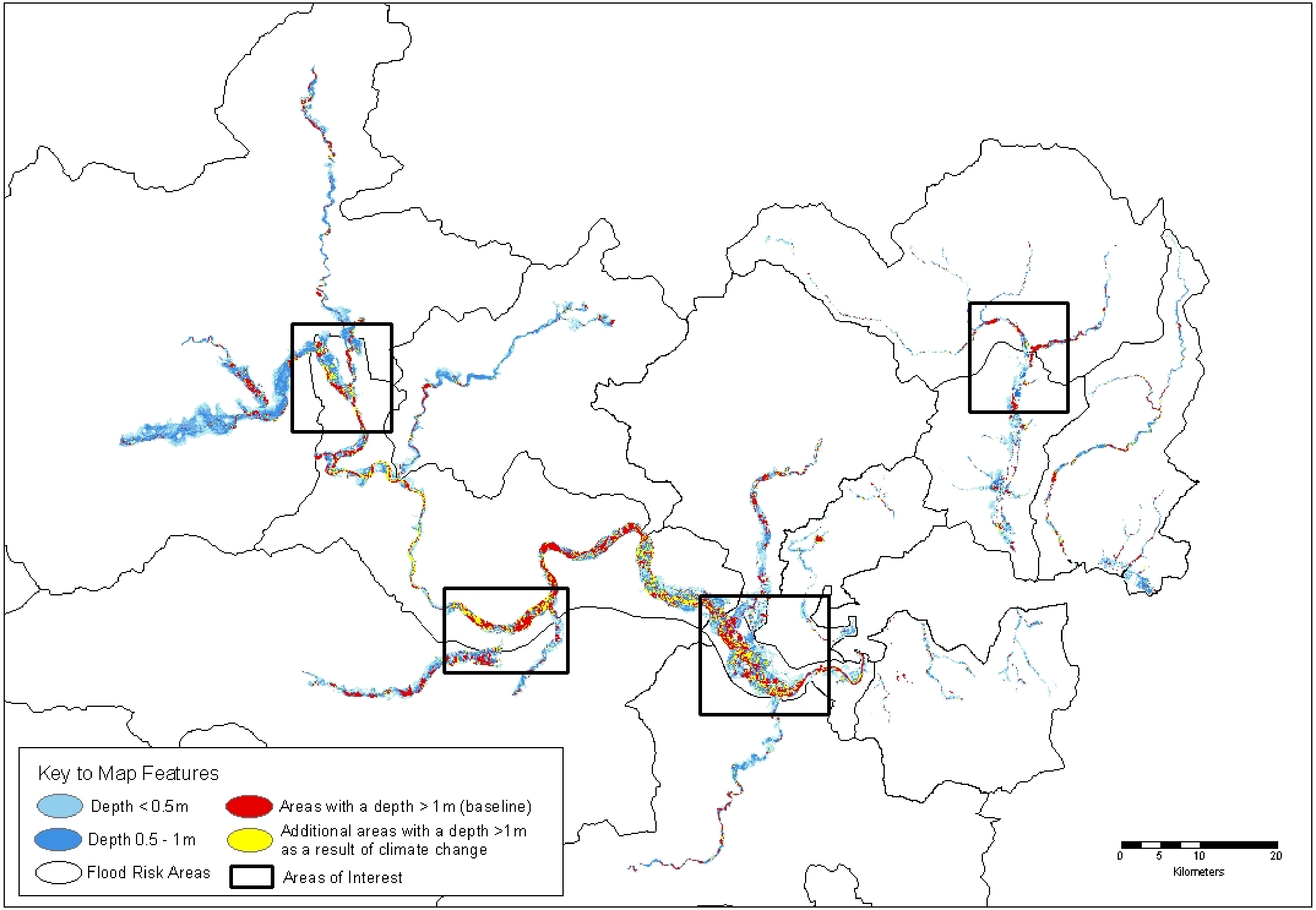


Figure 4.18 Regional depth map for the 1% AEP flood event (baseline and +20% climate change)

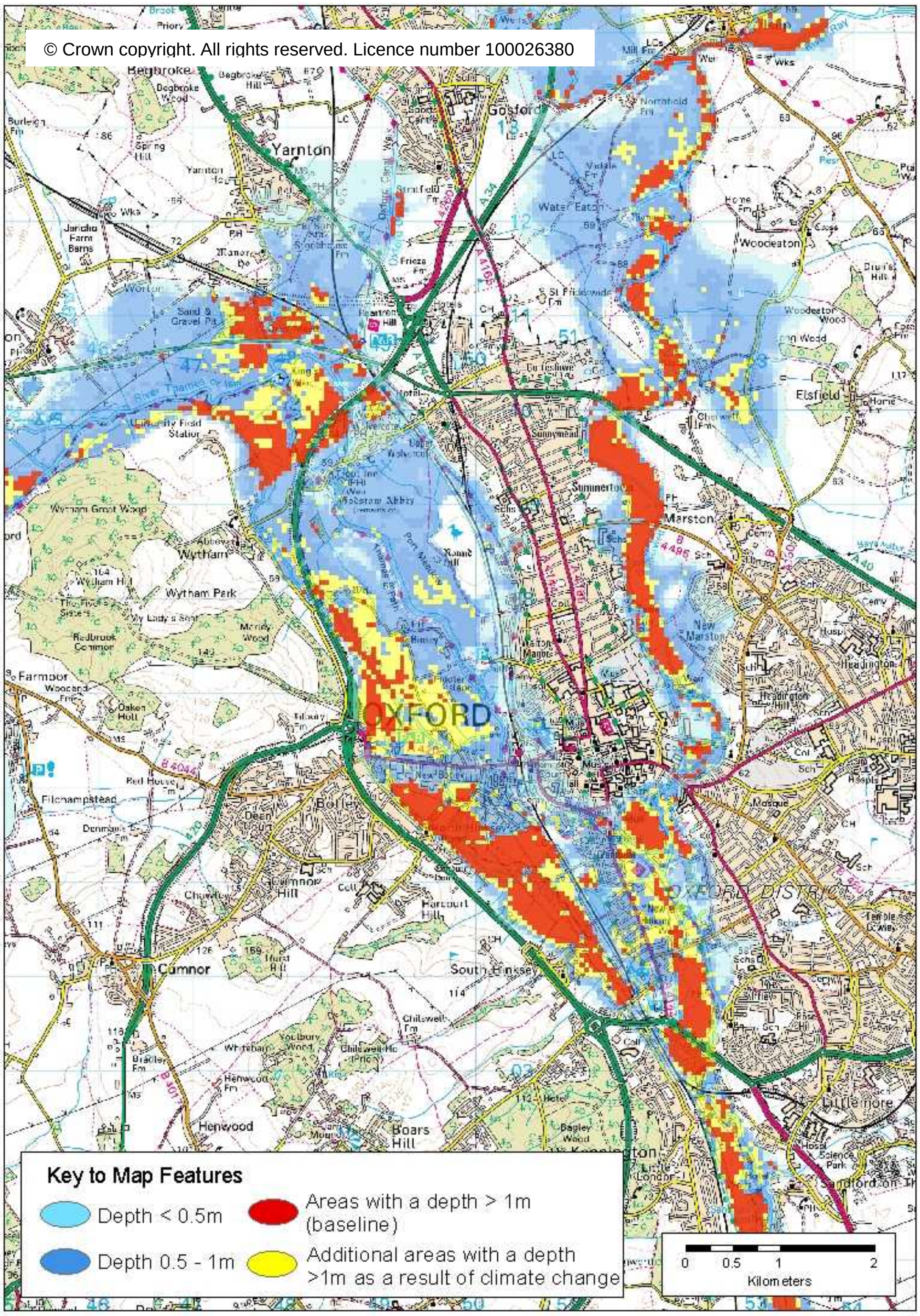


Figure 4.19 1% AEP flood depths (baseline and climate change) for Oxford

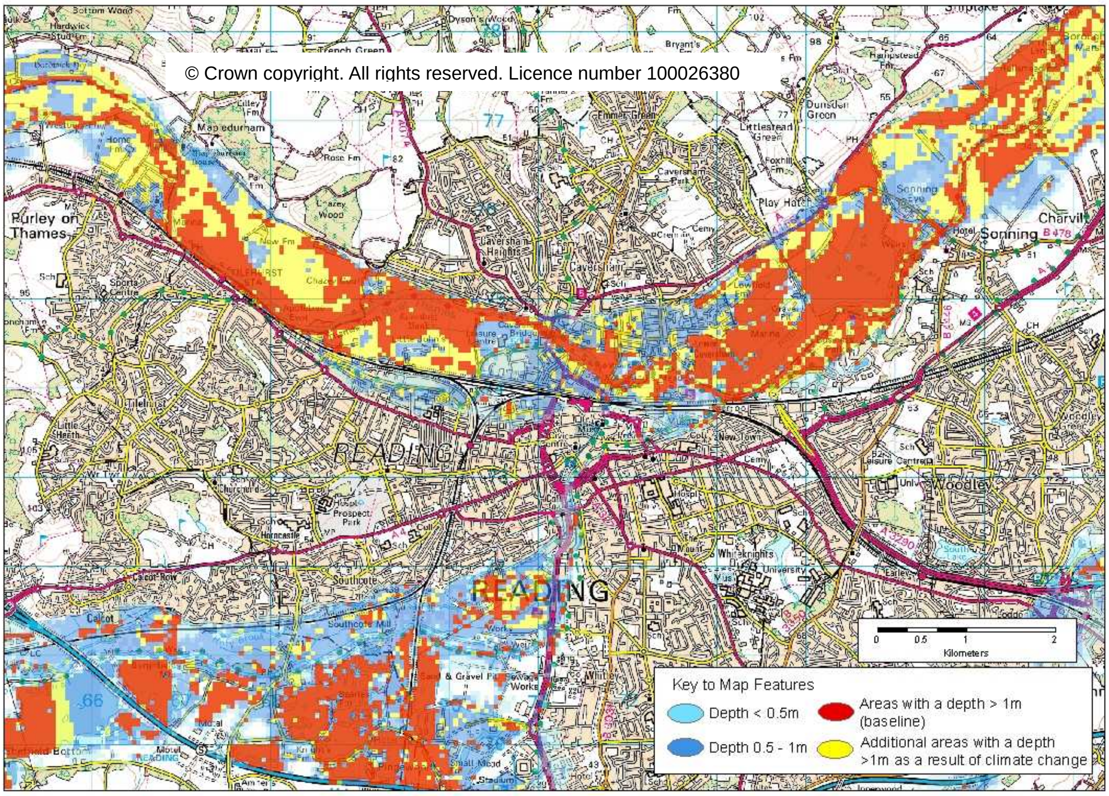


Figure 4.20 (above) 1% AEP flood depths (baseline and climate change) for Reading

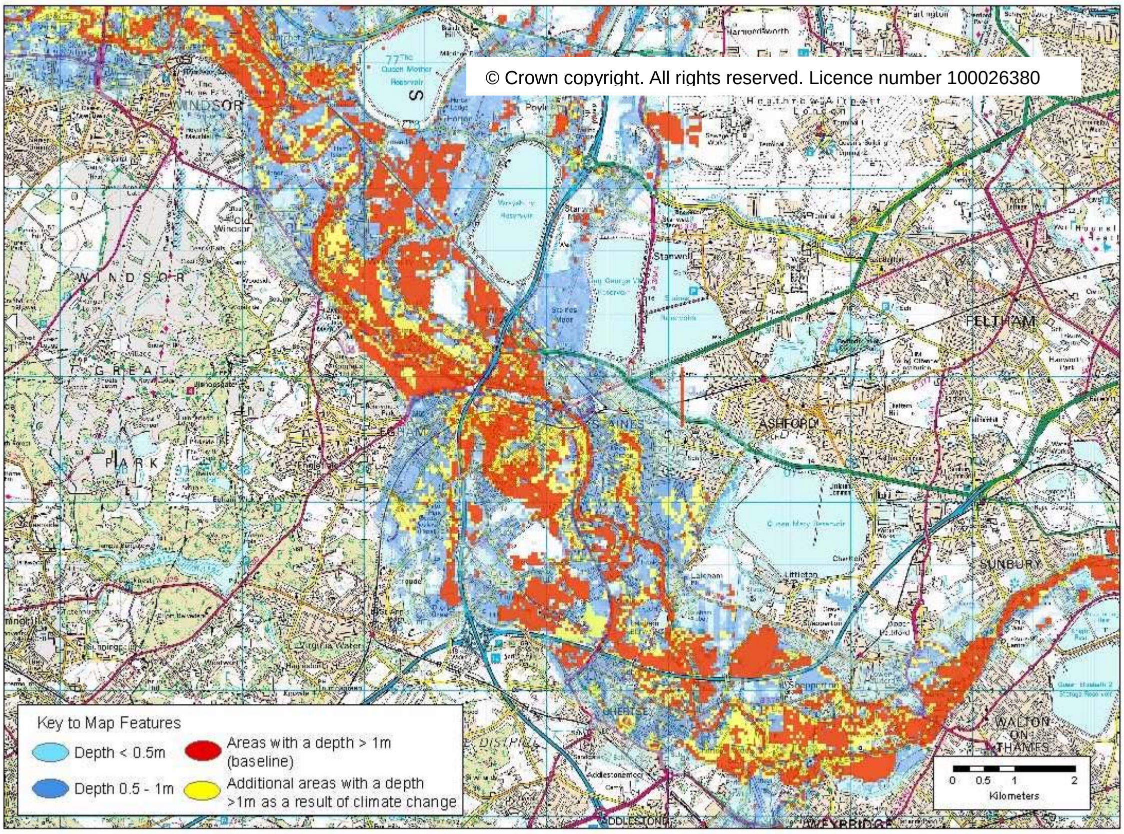


Figure 4.21 1% AEP flood depths (baseline and climate change) for the Lower Thames

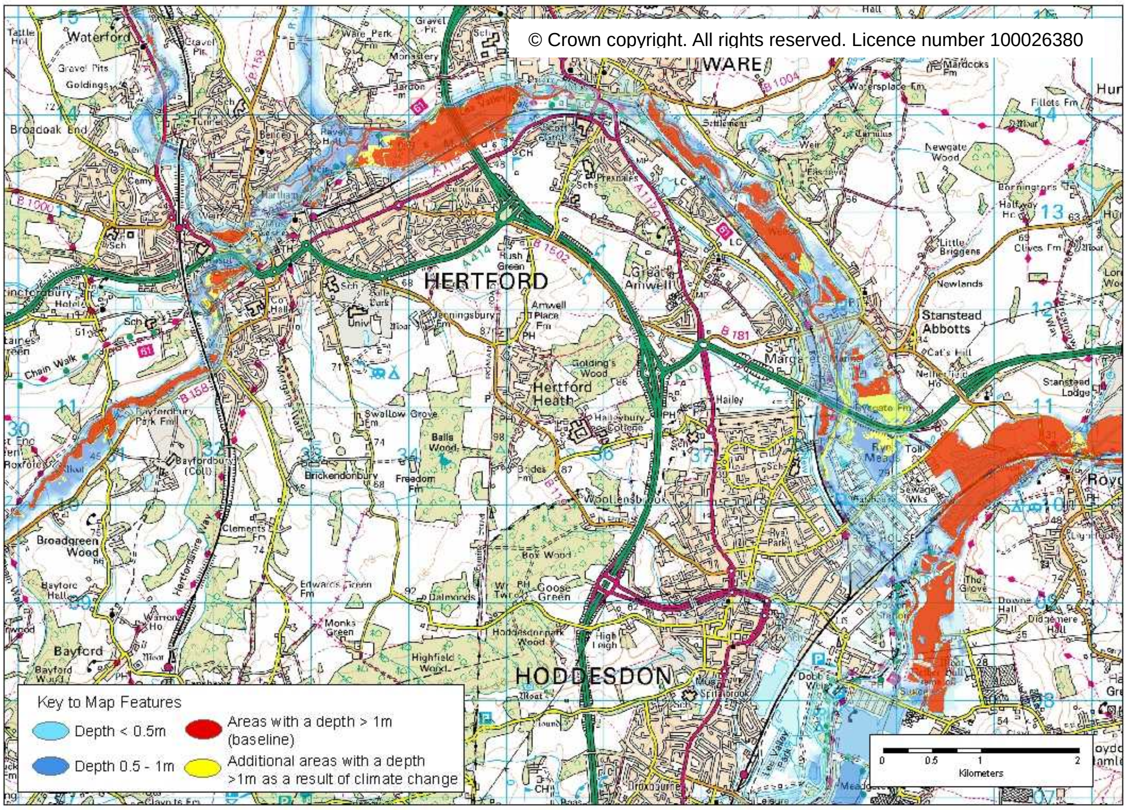


Figure 4.22 1% AEP flood depths (baseline and climate change) for Hertford (Upper Lee)

4.3.1 Flood risk to people

It has been shown that climate change will increase the area of floodplain for a defined flood event. As a result, more people will be affected by flooding (as many as 87,000 more properties). Table 4.1 shows the number of people at risk in each policy unit for a range of flood event AEPs and the percentage increase in the totals from the baseline (Chapter 3).

In Thames region as a whole, the number of people at risk increases by 16% for a 1% AEP event as a result of climate change. The percentage increase is larger for the lower order events (24% for the 20% AEP event). The largest increases in people at risk for the 1% AEP event are in the Lower Mole, Lower Lee tributaries and Luton policy units.

Policy Unit	**20% AEP**		**10% AEP**		**4% AEP (5% AEP in London)**		**1% AEP**		**0.5% AEP**	
	Total	% increase from baseline	Total	% increase from baseline	Total	% increase from baseline	Total	% increase from baseline	Total	% increase from baseline
Abingdon	3373	3.3%	3618	8.3%	3976	9.9%	4318	5.3%	4421	2.9%
Addlestone Bourne, Emm Brook, The Cut										
Aylesbury	2878	25.5%	3517	25.1%	4178	18.8%	5578	22.8%	6111	17.5%
Basingstoke										
Beam	419	27.4%			758	21.7%	1296	36.8%		
Beverley Brook										
Brent	3186	28.8%			4804	19.5%	7067	17.7%		
Byfleet and Weybridge	979	12.1%	1233	26.0%	1762	47.5%	2351	24.1%	2518	12.6%
Colne	10033	14.7%	11039	11.5%	14407	28.7%	17377	12.1%	17937	5.0%
Colne tributaries and Wye										
Crane	8483	18.6%			14461	17.2%	19348	12.3%		
Graveney	5805	16.6%			7709	11.9%	9545	8.8%		
Guildford	1649	5.3%	1791	9.0%	1852	4.3%	2187	17.7%	2338	20.3%
Hoe Stream										
Hogsmill	1067	9.7%					3479	35.9%		
Ingrebourne	900	32.5%			2012	10.8%	2617	6.2%		
Kennet	4091	11.7%	4905	22.1%	5729	19.5%	7567	28.6%	7999	13.5%
Loddon	729	8.4%	833	15.3%	842	11.0%	1296	28.3%	1528	32.1%
Lower Lee	9774	62.4%	20106	88.6%	37845	63.4%	56088	16.0%	58565	5.4%
Lower Lee tributaries	2171	32.6%	3474	53.6%	7585	79.5%	18281	49.5%	20943	20.1%
Lower Mole	252	77.8%	443	159.2%	907	115.5%	1996	89.9%	2223	39.2%
Lower Roding	243	129.8%			749	81.0%	956	14.6%		
Lower Thames	36464	42.7%	45383	38.0%	57589	31.6%	72506	19.9%	74311	6.8%
Luton	47	90.9%	590	69.0%	1175	69.5%	2642	54.5%	3146	19.8%
Middle Lee and Stort	2603	24.8%	3110	14.3%	3917	17.0%	6536	31.3%	7162	10.5%
Middle Mole										
Middle Roding	54	140.0%			626	115.5%	6264	15.1%		
Ock										
Oxford	5857	102.1%	8921	104.5%	11765	36.4%	14252	16.6%	15392	14.4%
Pinn										

Ravensbourne	9333	19.8%			12026	14.2%	17188	16.2%		
Reading	7146	94.0%	8867	42.8%	10798	30.1%	11855	7.7%	12355	7.3%
Rural Wey	1058	9.8%	1166	12.4%	1287	10.4%	1456	8.4%	1591	12.4%
Sandford to Cookham	5733	27.0%	7301	35.8%	10717	53.2%	15156	30.6%	15705	7.7%
Swindon										
Thame	167	7.2%	178	12.9%	232	28.8%	349	42.2%	416	39.1%
Upper and Middle Blackwater										
Upper Lee	963	7.3%	1004	4.0%	1071	4.6%	1199	5.5%	1242	4.2%
Upper Mole										
Upper Roding	2084	54.6%			3116	15.4%	3967	8.2%		
Upper Thames	5486	21.7%	6649	25.3%	7837	18.8%	9846	17.2%	10249	6.2%
Wandle	8926	20.2%			12474	17.4%	15482	10.7%		
Windsor and Maidenhead	4138	111.9%	7754	141.7%	15287	112.6%	26620	47.7%	27871	14.4%

Table 4.1 Increase in the number of people at risk at a result of climate change

There will also be an increase in the numbers of properties at risk in enumeration districts with an SFVI of 4 or 5. The proportion of properties in enumeration districts with an SFVI of 4 or 5 in relation to the total number at risk under the climate change scenario is shown in Table 4.2. It is a particularly important issue in London where the lead-time is shorter and flash flooding is more common. The percentage increase in the number of people at risk who also live in areas with an SFVI value of 4 or 5, is also shown per policy unit in Table 4.2

Policy Unit	**No. of people at risk in areas with a high social flood vulnerability (1% AEP)**	**As a % of the total people at risk (1% AEP)**	**% increase from baseline 1% AEP event**
Abingdon	2477	57.4%	4.0%
Addlestone Bourne, Emm Brook, The Cut			
Aylesbury	2714	48.6%	14.3%
Basingstoke			
Beam	396	30.6%	44.3%
Beverley Brook			
Brent	2738	38.7%	18.0%
Byfleet and Weybridge	277	11.8%	12.8%
Colne	3994	23.0%	10.7%
Colne tributaries and Wye			
Crane	3344	17.3%	17.8%
Graveney	2903	30.4%	7.7%
Guildford	686	31.4%	8.9%
Hoe Stream			
Hogsmill	1352	38.9%	22.7%
Ingrebourne	1406	53.7%	4.2%
Kennet	2140	28.3%	14.9%
Loddon	239	18.4%	60.6%
Lower Lee	56054	99.9%	15.9%
Lower Lee tributaries	8818	48.2%	37.9%
Lower Mole	23	1.1%	n/a
Lower Roding	322	33.6%	30.0%
Lower Thames	10640	14.7%	22.0%
Luton	1724	65.2%	38.0%
Middle Lee and Stort	954	14.6%	36.3%
Middle Mole			
Middle Roding	5220	83.3%	13.8%
Ock			
Oxford	9333	65.5%	10.8%
Pinn			
Ravensbourne	5596	32.6%	13.4%
Reading	2171	18.3%	3.3%
Rural Wey	126	8.7%	0.0%
Sandford to Cookham	4862	32.1%	28.9%
Swindon			
Thame	155	44.5%	38.0%
Upper and Middle Blackwater			
Upper Lee	416	34.7%	5.7%
Upper Mole			
Upper Roding	1379	34.8%	9.7%

Upper Thames	3398	34.5%	16.5%
Wandle	4399	28.4%	7.5%
Windsor and Maidenhead	4901	18.4%	71.2%

Table 4.2 Social flood vulnerability under the climate change scenario

It is more difficult to quantify some of the potentially more severe impacts of climate change. For example, an increase in pluvial flooding (due to increases in the frequency and intensity of thunderstorms) is a likely consequence of climate change. The impacts of these storms on the urban catchments in the region could be severe. This is because of the inadequate drainage systems in many urban areas, the very fast response of the catchments, and the difficulty in predicting precisely when and where the storms will occur.

A full evaluation of the impacts of thunderstorms and their increased frequency due to climate change is beyond the scope of this work. However, we have taken this uncertainty into account in our policy appraisal and action plan for future work.

4.3.2 Flood risk to property and social economic development

The total AAD for the Thames CFMP area under the climate change scenario is £562 million. This is an increase of approximately 40%. The proportion of damages across the three river basins is broadly similar to the AAD for the baseline conditions. The contribution to total damages from the London rivers is 6% less and the Thames basin contributes 3% more. For the 1% AEP damages, the Thames basin contributes 57% of the total damages (compared to 44% for the baseline 1% AEP event) and the London rivers contribute less (21% compared to 38% for the baseline event). For both AAD and 1% AEP damages, the percentage contribution from the Lee basin remains roughly the same.

The largest percentage increase in AAD is in the Lee basin where damages increase by 64% (from £52 million to £86 million). In the Thames basin, AAD increases by 52% (from £233 million to £356 million). The London rivers are less responsive to changes in climate and AAD increases here by 16% (from £104 million to £121 million). Figure 4.23 illustrates this. The Thames basin has the greatest increase in damages for the 1% AEP event (65%).

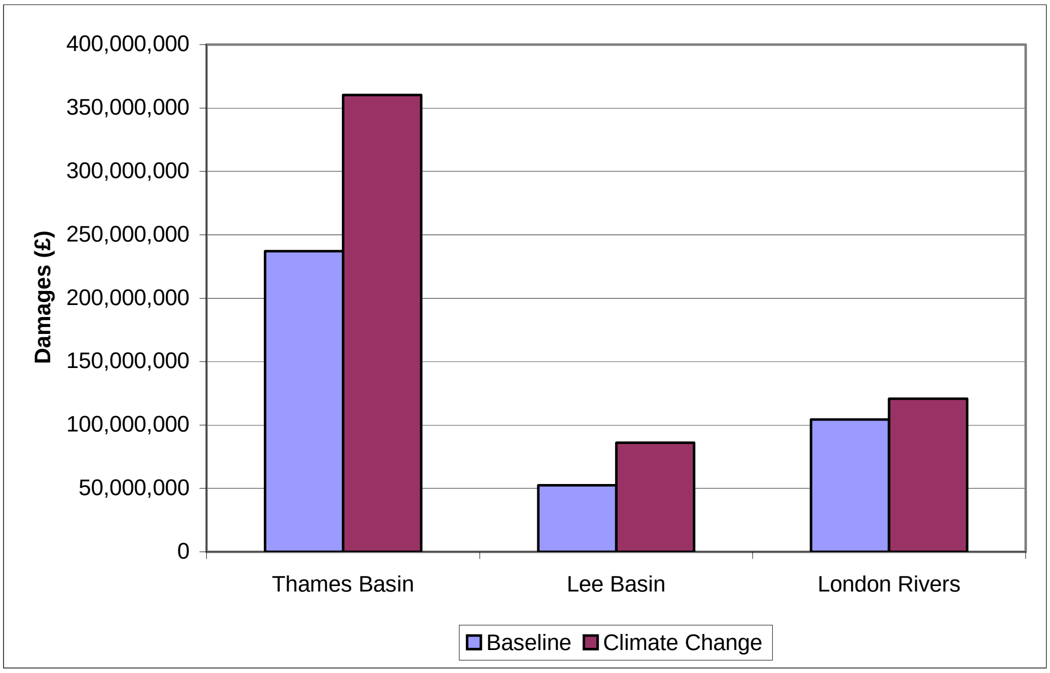


Figure 4.23 Increases in AAD as a result of climate change, in relation to the baseline (present day)

Table 4.3 provides a breakdown of the number of properties at risk for the 20%, 10%, 4% (5% in London), 1% and 0.5% AEP event per policy unit.

Table 4.4 provides a breakdown of the economic damages for the 20%, 10%, 4% (5% in London), 1% and 0.5% AEP event and AAD per policy unit.

The policy units with the greatest increases in properties for the 1% AEP event are the Lower Mole, Luton, Lower Lee tributaries and Windsor and Maidenhead. Some policy units are more responsive to the lower order events and the largest increase in properties is greater for the 4% AEP (5% AEP in London) in a number of policy units, for example the Colne, Byfleet and Weybridge, Lower Lee and the Lower Roding. The greatest increase in damages tend to be in the urban areas (Oxford, Luton, Reading) and those with wide, flat floodplains where there is a greater increase in the floodplain extent (Lower Thames, Lower Mole, Lower Lee). Large increases in damages but not properties would suggest that the water depths increase as a result of climate change rather than the flood extent, causing greater damage to the properties already at risk.

Policy Unit	20% AEP		10% AEP		4% AEP (5% AEP in London)		1% AEP		0.5% AEP	
	Total	% increase from baseline	Total	% increase from baseline	Total	% increase from baseline	Total	% increase from baseline	Total	% increase from baseline
Abingdon	1499	3.3%	1608	8.3%	1767	9.9%	1919	5.3%	1965	2.9%
Addlestone Bourne, Emm Brook, The Cut										
Aylesbury	1279	25.5%	1563	25.1%	1857	18.8%	2479	22.8%	2716	17.5%
Basingstoke										
Beam	186	27.4%			337	21.7%	576	36.8%		
Beverley Brook										
Brent	1416	28.8%			2135	19.5%	3141	17.7%		
Byfleet and Weybridge	435	12.1%	548	26.0%	783	47.5%	1045	24.1%	1119	12.6%
Colne	4459	14.7%	4906	11.5%	6403	28.7%	7723	12.1%	7972	5.0%
Colne tributaries and Wye										
Crane	3770	18.6%			6427	17.2%	8599	12.3%		
Graveney	2580	16.6%			3426	11.9%	4242	8.8%		
Guildford	733	5.3%	796	9.0%	823	4.3%	972	17.7%	1039	20.3%
Hoe Stream										
Hogsmill	474	9.7%					1546	35.9%		
Ingrebourne	400	32.5%			894	10.8%	1163	6.2%		
Kennet	1818	11.7%	2180	22.1%	2546	19.5%	3363	28.6%	3555	13.5%
Loddon	324	8.4%	370	15.3%	374	11.0%	576	28.3%	679	32.1%
Lower Lee	4344	62.4%	8936	88.6%	16820	63.4%	24928	16.0%	26029	5.4%
Lower Lee tributaries	965	32.6%	1544	53.6%	3371	79.5%	8125	49.5%	9308	20.1%
Lower Mole	112	77.8%	197	159.2%	403	115.5%	887	89.9%	988	39.2%
Lower Roding	108	129.8%			333	81.0%	425	14.6%		
Lower Thames	16206	42.7%	20170	38.0%	25595	31.6%	32225	19.9%	33027	6.8%
Luton	21	90.9%	262	69.0%	522	69.5%	1174	54.5%	1398	19.8%
Middle Lee and Stort	1157	24.8%	1382	14.3%	1741	17.0%	2905	31.3%	3183	10.5%
Middle Mole										
Middle Roding	24	140.0%			278	115.5%	2784	15.1%		
Ock										
Oxford	2603	102.1%	3965	104.5%	5229	36.4%	6334	16.6%	6841	14.4%
Pinn										
Ravensbourne	4148	19.8%			5345	14.2%	7639	16.2%		

Reading	3176	94.0%	3941	42.8%	4799	30.1%	5269	7.7%	5491	7.3%
Rural Wey	470	9.8%	518	12.4%	572	10.4%	647	8.4%	707	12.4%
Sandford to Cookham	2548	27.0%	3245	35.8%	4763	53.2%	6736	30.6%	6980	7.7%
Swindon										
Thame	74	7.2%	79	12.9%	103	28.8%	155	42.2%	185	39.1%
Upper and Middle Blackwater										
Upper Lee	428	7.3%	446	4.0%	476	4.6%	533	5.5%	552	4.2%
Upper Mole										
Upper Roding	926	54.6%			1385	15.4%	1763	8.2%		
Upper Thames	2438	21.7%	2955	25.3%	3483	18.8%	4376	17.2%	4555	6.2%
Wandle	3967	20.2%			5544	17.4%	6881	10.7%		
Windsor and Maidenhead	1839	111.9%	3446	141.7%	6794	112.6%	11831	47.7%	12387	14.4%

Table 4.3 Increase in the number of properties at risk as a result of climate change

Policy Unit	20% AEP		10% AEP		4% AEP (5% AEP in London)		1% AEP		0.5% AEP		0.1% AEP	AAD	
	Total (£M)	% increase from baseline	Total (£M)	% increase from baseline	Total (£M)	% increase from baseline	Total (£M)	% increase from baseline	Total (£M)	% increase from baseline	Significance	Total (£M)	% increase from baseline
Abingdon	36.46	45.4%	45.10	33.2%	56.95	27.1%	77.03	17.5%	81.90	11.3%		9.57	30.2%
Addlestone Bourne, Emm Brook, The Cut													
Aylesbury	37.70	14.2%	42.18	14.4%	49.34	16.9%	63.81	20.9%	73.50	24.6%	Y	7.39	19.0%
Basingstoke													
Beam	2.13	11.5%			4.71	28.0%	11.51	69.2%				0.95	35.7%
Beverley Brook											Y		
Brent	28.61	41.3%			60.24	55.1%	130.80	35.2%				6.74	41.9%
Byfleet and Weybridge	24.47	22.6%	28.34	19.2%	33.24	17.7%	46.81	32.7%	50.36	12.4%		5.54	19.3%
Colne	270.84	15.2%	306.24	14.9%	368.80	18.2%	520.87	25.4%	566.93	13.6%		61.64	16.9%
Colne tributaries and Wye													
Crane	27.23	32.1%			128.37	43.8%	253.20	23.1%				20.82	33.6%
Graveney	27.94	46.6%			58.35	27.6%	102.11	21.4%			Y	10.11	29.0%
Guildford	92.61	8.8%	98.19	8.0%	104.93	7.2%	118.82	10.8%	127.95	12.2%		17.68	7.8%
Hoe Stream													
Hogsmill	16.90	15.3%					42.60	43.3%				4.79	25.7%
Ingrebourne	8.91	54.3%			61.50	58.2%	137.12	26.7%				8.21	37.5%
Kennet	48.67	22.3%	60.48	31.5%	91.77	55.8%	140.81	37.0%	166.95	37.6%		14.53	36.5%
Loddon	10.38	21.2%	11.75	17.8%	13.42	15.8%	18.27	27.6%	21.67	31.2%		2.54	19.7%
Lower Lee	20.97	113.7%	101.31	339.5%	404.27	184.8%	1268.28	50.7%	1413.81	15.3%		57.10	79.0%
Lower Lee tributaries	20.98	61.7%	38.27	70.0%	63.85	48.4%	243.03	98.9%	308.55	37.2%		13.05	64.9%
Lower Mole	0.91	40.4%	2.76	242.9%	8.28	222.5%	36.41	228.2%	39.87	63.7%	Y	1.50	159.2%
Lower Roding	3.02	6.7%			6.83	88.9%	22.77	23.3%				1.49	39.3%
Lower Thames	317.93	84.0%	521.40	102.4%	921.82	93.0%	1690.20	61.0%	1724.96	14.9%		131.37	71.0%
Luton	0.01	12.8%	0.16	532.7%	0.45	85.0%	10.36	584.0%	17.87	74.5%	Y	0.35	199.8%
Middle Lee and Stort	40.81	13.8%	50.55	19.6%	71.00	26.7%	137.90	50.6%	170.09	26.1%		10.81	26.1%
Middle Mole													
Middle Roding	0.55	56.6%			3.34	300.4%	105.49	70.5%				3.48	78.5%
Ock													
Oxford	16.02	120.5%	38.38	239.8%	100.51	186.7%	295.20	136.5%	375.73	59.4%		16.26	139.8%

Pinn													
Ravensbourne	72.40	36.4%			132.45	29.1%	246.62	27.0%				22.53	29.4%
Reading	36.30	78.5%	80.85	160.5%	200.60	185.9%	424.83	80.0%	516.77	49.5%		27.15	106.7%
Rural Wey	22.63	11.0%	24.18	8.7%	26.41	9.3%	31.50	14.9%	35.10	17.8%		4.25	11.5%
Sandford to Cookham	53.75	51.2%	74.04	53.4%	135.90	92.3%	334.15	92.0%	380.35	25.8%		21.55	64.0%
Swindon													
Thame	1.95	15.9%	2.26	18.9%	2.99	34.1%	7.52	90.4%	11.19	86.0%		0.49	53.8%
Upper and Middle Blackwater													
Upper Lee	17.91	22.8%	23.01	22.3%	29.59	17.4%	40.06	16.5%	45.53	15.2%		4.63	15.2%
Upper Mole													
Upper Roding	12.75	73.7%			31.05	55.1%	61.47	26.9%				5.11	49.0%
Upper Thames	50.85	37.3%	72.13	55.0%	114.50	58.2%	197.57	43.9%	235.39	30.6%		16.62	48.3%
Wandle	230.85	10.8%			353.58	26.3%	505.68	19.3%				36.55	30.7%
Windsor and Maidenhead	20.55	85.9%	33.69	99.2%	87.25	185.1%	426.91	248.1%	505.01	55.2%		17.62	135.4%

Table 4.4 Increase in economic damages as a result of climate change

N.B. The potential impact of a future 0.1% AEP flood has been assessed (see Table 4.4a below). If the impacts are potentially significant, they have been indicated in the table above (with a “Y” in the 0.1% AEP significance column).

Under the climate change scenario, in the Thames basin, 16% of the total number of properties affected by a 1% AEP flood are in areas with a depth of flooding greater than one metre (compared to 7% for the 1% AEP baseline event). There is a similar percentage increase in the London rivers, where the number of properties increases from 8 to 14%. In the Lee basin, there is a smaller increase from 6 to 8%.

The distribution of properties in the Thames fluvial floodplain that are affected by flooding of more than 1 m in depth (for a 1% AEP event) is shown in figure 4.24. The increase in the area affected by deeper flooding, as a result of climate change, leads to a large increase in property numbers at some locations, namely Oxford, Reading and the Lower Thames.

In the Lee basin, total numbers of properties in areas of deeper flooding are much lower and clustered in a small number of locations. This is shown in figure 4.25.

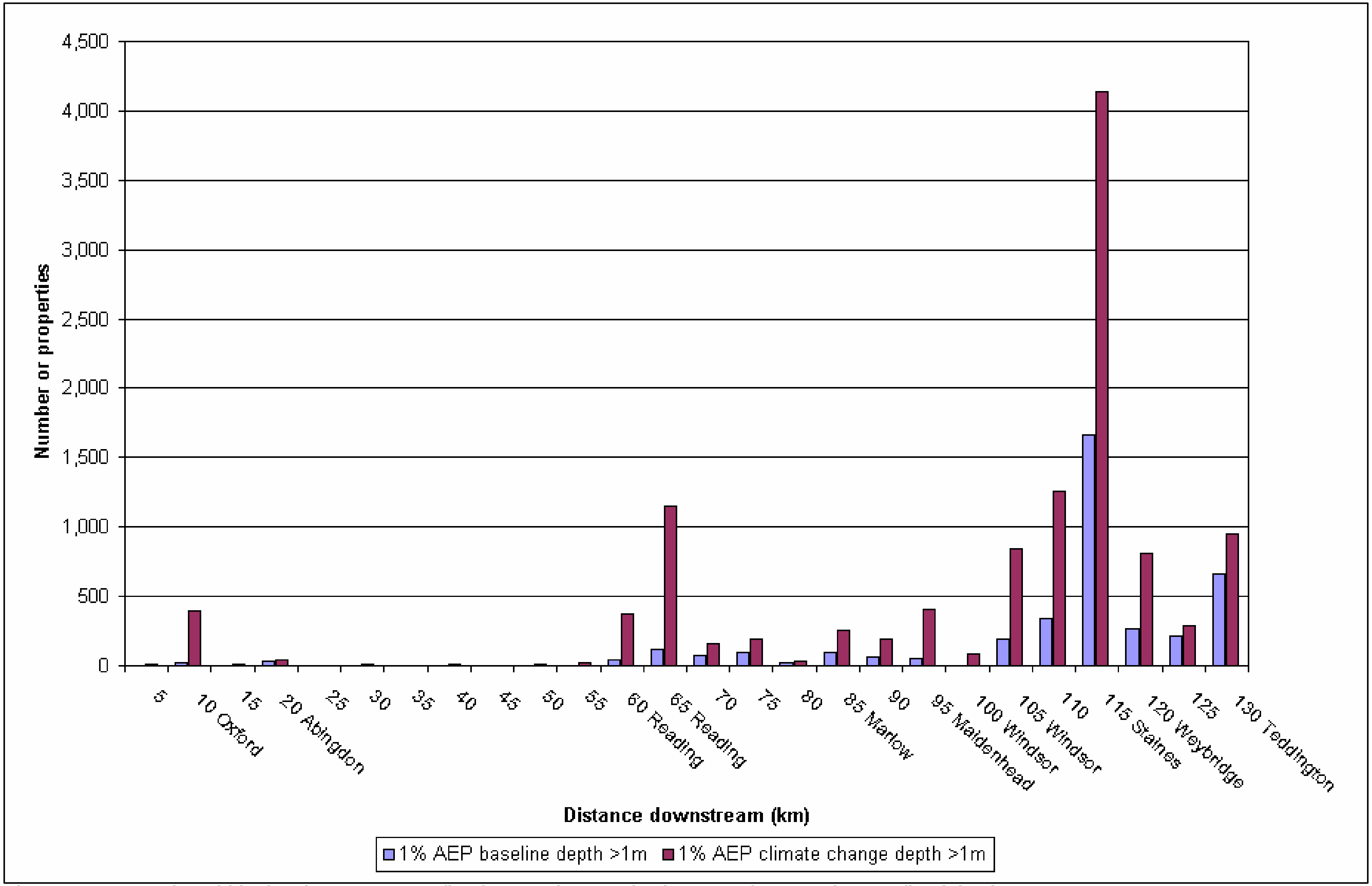


Figure 4.24 Properties within the Thames 1% AEP flood extent that are also in areas of greater than 1m flood depth

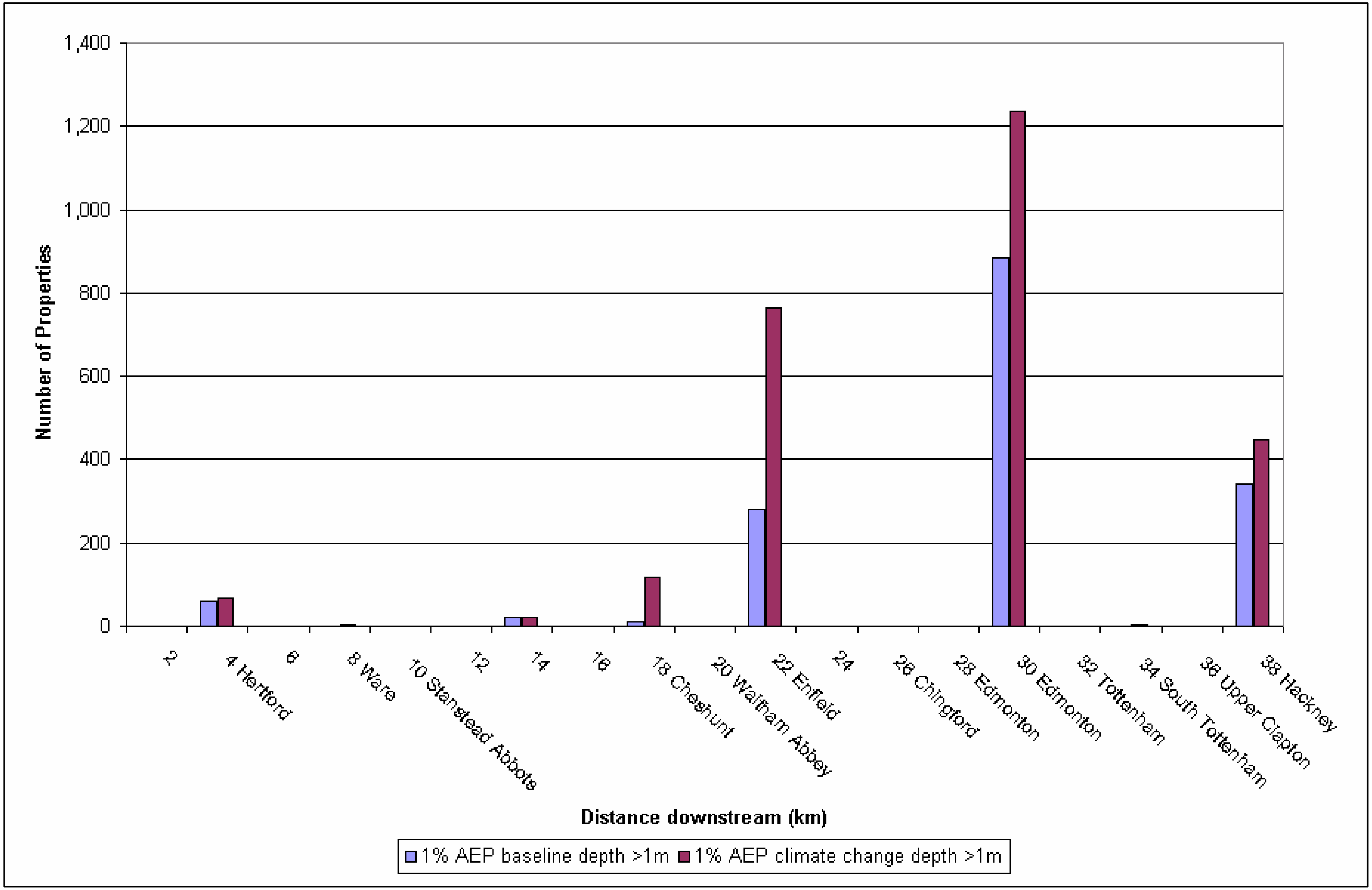


Figure 4.25 Properties within the Lee 1% AEP flood extent that are also in areas of greater than 1m flood depth

Estimation of the impact of a major flood event (0.1% AEP) for the climate change scenario

The largest scale event that was modelled with MDSF under a future climate change scenario was a 0.5% AEP event. In order to allow us to understand the extent and consequence of a future 0.1% AEP event (taking account of climate change) we have extrapolated the MDSF data using the following methodology for each policy unit:

1. Plot all the existing available data from MDSF for floodplain extents (km^2) for both current and future flood risk.
2. Using a trend line, extrapolate the future flood risk data to calculate the estimated extent of the floodplain (km^2) for a 0.1% AEP event.
3. To verify the robustness of this interpolation we have used the current flood risk trend line (the data for which has been ground-truthed against detailed catchment modelling) as a check.
4. Calculate the incremental increase in floodplain extent (both in real and percentage terms) between the 0.5% AEP (1% AEP in London) and 0.1% AEP future flood risk scenario. This allows us to make a quantitative assessment of the scale of the increase in extent.
5. Using a map showing the change in floodplain extent between Flood Zones 2 and 3 we made an assessment as to where the increase in floodplain extent (as calculated in 4) is likely to occur. For those policy units where the projected increase in extent is more than 10%, then this method may be inappropriate. Where this occurred we used the maps of existing floodplain outlines, topography and land use to make a judgement on the possible consequences.
6. Knowing where the increased flood extent is likely to occur and using our knowledge of the catchment and location of urban settlements, we have made a qualitative assessment of whether this increase is likely to have a significant impact on damages in the policy unit.

The potential consequences of an extreme future flood event are outlined for each policy unit in table 4.5 below. The output from the methodology described above is detailed in the subsequent table (table 4.6).

Policy Unit	**Potential consequence of an extreme future flood event (H – High, M - Medium, L – Low)**	**Commentary**
Abingdon	L	There is an increase in the area of floodplain along the River Thames, Ock and on some of the minor tributaries in the order of 1% for a 0.1% AEP event compared with a 0.5% AEP event. The

		difference is therefore very small in this policy unit. There could also be impacts towards the headwaters of the River Stert.
Addlestone Bourne, Emm Brook	L	There is a possible increase in the extent of floodplain on the upper reaches of the Addlestone Bourne. The more uncertain impacts of a very extreme event in this policy unit would be on surface water flooding. We have an action to investigate surface water flooding in this policy unit.
Aylesbury	H	Indications are that there may be some large increases in the area of floodplain for a very extreme flood event in Aylesbury. This includes both the River Thame and the Bear Brook.
Basingstoke	L	The potential impacts in Basingstoke are uncertain because so much of the main river through the town is in culvert. There are also additional uncertainties in this policy unit from the impacts of surface water flooding. We have an action to investigate surface water flooding in this policy unit.
Beam	M	The flood mapping shows that there are 2 new areas containing approximately 150 houses that will be at flood risk in the future in the south of Romford centre. There is generally a small increase to the extent of the flooding through the town. The policy to ensure that redevelopment brings about adaption to flooding in Romford is therefore very important.
Beverley Brook	H	In the Beverley Brook the biggest potential increase in risk from extreme flooding is from a combined tidal and fluvial flood event and surface water flooding. This is an issue that is being addressed within the Thames 2100 project.
Brent	L	The flood mapping indicates that any increase in area of the flood plain is likely to be spread evenly along the policy unit. There are a few locations (Greenford, Wembley, East of Kenton) where the flood extent expands into neighbouring roads increasing the flood risk for some 30 houses in each location. At the top of Edgware Brook in Stanmore it is possible that some additional properties will become at risk of flooding. Ensuring that the flood plain is protected and where possible widening river corridors though redevelopment are important in ensuring that we minimise the impacts of future flood risk.
Byfleet and Weybridge	L	There is an increase in the area of floodplain in this policy unit of approximately 7% for a 0.1% AEP event compared with a 0.5% AEP event. In Byfleet and Weybridge there is a large increase in the number of properties at risk

		between a 1% and 0.1% event for the current risk. It is already recognised Byfleet and Weybridge may be particularly susceptible to a very extreme flood event.
Colne	L	There is an increase in the area of floodplain in this policy unit of approximately 4% for a 0.1% AEP event compared with a 0.5% AEP event. The Colne is characterised by a wide flat floodplain which tends to flood extensively in more frequent events. There can be a high degree of confidence that the flood outlines for a future 0.5% AEP will be very similar to a future 0.1% event.
Colne tributaries and Wye	L	These are steep, chalk catchments with narrow valleys and floodplains. They are particularly susceptible to groundwater flooding. Indications are that the spatial extent of flooding would only increase marginally. However, there are potential impacts arising from the duration of flooding (groundwater) and velocity of flow.
Crane	M	The increase in area of fluvial flooding centres mostly around North West Twickenham and St Margarets where we might expect to see an additional 100 properties at risk of flooding. In addition to these areas, there are small clusters of houses in Yeading, Craford and South Ruislip which are likely to experience increased flood risk (about 50 houses each). Twickenham is also at risk of tidal flooding. Adaption is critical in terms of ensuring consequence of increase flood extents are minimised.
Graveney	H	The Graveney has a steep catchment and so increase in extent is small and confined. The 2 main areas where the flood risk is expected to increase are Tooting (approx 500 houses) and Colliers Wood (100 properties). Making sure that we get redevelopment right in these locations is very important. Management of surface water is critical in this catchment.
Guildford	M	The flood plain is narrow through the centre of Guildford. There are some small areas to the North West of the centre where there is likely to be increased risk to both commercial and residential (about 100) properties. The actions to manage the consequences of flooding through redevelopment and adaption will be very important.
Hoe Stream	L	There is a small increase in the extent of the extreme flood outline indicated in the Hoe Stream. The main areas are upstream of Woking and could have small scale impacts at locations such as Worplesdon and Fox Corner.
Hogsmill	M	There are considerable areas of Kingston

		which are likely to be at risk of flooding (mostly from the Thames). The message of adaption and getting development right in the future is key here. Along the head waters of the Surbiton Stream there is are considerable numbers of properties that are likely to be at risk of flooding.
Ingrebourne	L	The increase in area of fluvial flooding is mainly in rural areas where there are few properties. In Upminster there is a small area where about 40 houses are likely to experience increasing flood risk.
Kennet	L	There is an increase in the area of floodplain in this policy unit of approximately 2% for a 0.1% AEP event compared with a 0.5% AEP event. Areas that could be impacted include the south side of Theale where there is commercial property at risk of flooding.
Loddon	L	There is an increase in the area of floodplain in this policy unit of approximately 6% for a 0.1% AEP event compared with a 0.5% AEP event. Possible areas where there may be increases in the extent of the floodplain include the Twyford Brook.
Lower Lee and Lower Lee tributaries	M	There is an increase in the area of floodplain in this policy unit of approximately 5% for a 0.1% AEP event compared with a 0.5% AEP event. The areas where the floodplain extent is larger for a 0.1% future event are close to the confluences with the Lower Lee tributaries. In many of these areas there is large scale redevelopment taking place and it is important that through this redevelopment we bring about adaptation of the urban environment so that it is more resilient to flooding. This is a key feature of our action plans for both the Lower Lee and Lower Lee tributaries.
Lower Mole	H	The Lower Mole is currently protected by substantial river defences with a 0.5% AEP standard (for current day risk). An extreme event would therefore have a significant impact on the Lower Mole and this has been identified in the assessment of current day risk and the need to improve the awareness and resilience of those at residual risk of flooding.
Lower Roding	L	There is likely to be only a small increase in flood plain extent which is spread quite evenly across the policy unit. Adaptation of the properties will be critical in terms of minimising any increases to flooding in the future as the flood plain extent increases.
Lower Thames	L	The floodplain in the Lower Thames is very wide and flat. The analysis shows that a 0.1% AEP future flood event could flood an additional 0.7km^2 (approx. an extra 1% of

		land) compared with a 0.5% AEP flood. The impact of this in the Lower Thames would be shallow flooding to some properties. However there are over 30,900 properties at risk in a 0.5% AEP Future event in this policy unit so the additional impacts are relatively small in the context of this policy unit.
Luton	H	There are a lot of houses in the North West of Luton that are likely to experience an increased risk of flooding. Our policy of intervention through making sure that the redevelopment of Luton will ensure a net reduction in risk will be key towards mitigating the impacts of climate change. In the headwaters of the catchment there are small areas which are likely to be affected, but these should be mitigated through the upstream storage that is recommended for the policy unit.
Middle and Upper Roding	L	The potential increase in flood extent is largely uniform along the length of the River Roding. The Upper Roding floodplain is, for the most part, natural with relatively few properties at risk of flooding.
Middle Lee and Stort	L	There is an increase in the area of floodplain in this policy unit of approximately 4% for a 0.1% AEP event compared with a 0.5% AEP event. The potential increase in flood extent is largely uniform along the length of the River Stort. The River Stort floodplain is, for the most part, natural with relatively few properties at risk of flooding outside of Bishops Stortford, Sawbridgeworth and Harlow.
Middle Mole	L	The potential increase in flood extent is largely uniform along the length of the River Mole. The Middle Mole floodplain is, for the most part, natural with relatively few properties at risk of flooding.
Ock	L	There are potential increases in the extent of flooding during an extreme event in the Ock catchment. The main area is in the natural floodplain between Charney Basset and Garford that could impact on a small number of isolated properties.
Oxford	L	The floodplain in Oxford is very wide and flat. The analysis shows that a 0.1% AEP future flood event could flood an additional $0.25km^2$ (approx. an extra 3% of land) compared with a 0.5% AEP flood. The impact of this in the Oxford would be shallow flooding to some properties. However there are over 6,800 properties at risk in a 0.5% AEP Future event in this policy unit so the additional impacts are relatively small in the context of this policy unit and not lead to a revision of policy.
Pinn	L	Indications are that there would only be a very small increase in the extent of the

		extreme outline under a Future scenario. The one area where there is a small increase in the flood extent could be on the River Pinn in Ruislip.
Ravensbourne	L	The increase in the area of fluvial flooding is in the headwaters of the catchment where there are very few properties at risk from flooding. The more uncertain impacts of a very extreme event in this policy unit would be on surface water flooding. We have an action to investigate surface water flooding in this policy unit.
Reading	L	The floodplain in Reading is very wide and flat. The analysis shows that a 0.1% AEP future flood event could flood an additional 0.13km^2 (approx. an extra 2% of land) compared with a 0.5% AEP flood. The impact of this in the Reading would be shallow flooding to some properties. However there are over 5,400 properties at risk in a 0.5% AEP Future event in this policy unit so the additional impacts are relatively small in the context of this policy unit and not lead to a revision of policy.
Rural Wey	L	There is an increase in the area of floodplain in this policy unit of approximately 7% for a 0.1% AEP event compared with a 0.5% AEP event. The potential increase in flood extent is largely uniform along the length of the River Wey. The River Wey floodplain is, for the most part, natural with relatively few properties at risk of flooding outside of Farnham, Godalming and Cranleigh Waters.
Sandford to Cookham	L	There is an increase in the area of floodplain in this policy unit of approximately 2% for a 0.1% AEP event compared with a 0.5% AEP event. Within the Thames floodplain, the indication is that there would not be a noticeable increase in the extent of flooding, but that some of the dry islands within the floodplain may be inundated. This has implications for emergency planning and emphasises the strong flood awareness message within this policy unit.
Swindon	M	In Swindon there are locations where there could be an increase in the extent of the extreme flood outline under a future scenario. This includes areas on the Dorcan Brook and River Cole.
Thame	L	There is an increase in the area of floodplain in this policy unit of approximately 3% for a 0.1% AEP event compared with a 0.5% AEP event. Most of the increase in potential extent is on the Baldon Brook where there are very few properties at risk from flooding (a few additional properties may be at risk in Drayton St Leonard).

Upper and Middle Blackwater	L	Within the Blackwater floodplain, the indication is that there would not be a noticeable increase in the extent of flooding, but that some of the dry islands within the floodplain may be inundated. This has implications for emergency planning and emphasises the strong flood awareness message within this policy unit.
Upper Lee	L	There is an increase in the area of floodplain in this policy unit of approximately 3% for a 0.1% AEP event compared with a 0.5% AEP event. Most of the increase in potential extent is on the lower reaches of the Mimram Brook where there are no properties at risk from flooding. There may also be increases in extent on the lower reaches of the Beane and Rib that could impact small areas in the north of Hertford.
Upper Mole	M	In the Upper Mole there are locations where there could be an increase in the extent of the extreme flood outline under a future scenario. This includes areas in and around Horley and Smallfield.
Upper Thames	L	There is an increase in the area of floodplain along the River Thames and in the very lower reaches of some tributaries in the order of 1% to 5%. In the headwaters the changes are negligible. Along with River Thames this *could* have a small impact on some settlements such as Ashton Keynes and Standlake. The proposed actions in this policy unit to increase the flood resilience and awareness will be important in these cases.
Wandle	L	There is likely to be only a small increase in flood plain extent which is spread quite evenly through the policy unit. Adaption of the properties will be critical in terms of minimising any increases to flooding in the future.
Windsor and Maidenhead	L	There is an increase in the area of floodplain in this policy unit of approximately 2% for a 0.1% AEP event compared with a 0.5% AEP event. Within the Windsor and Maidenhead floodplain, the indication is that there would not be a noticeable increase in the extent of flooding, but that some of the dry islands within the floodplain may be inundated. This has implications for emergency planning and emphasises the strong flood awareness message within this policy unit.

Table 4.5 Potential impact of a 0.1% AEP future event

Estimation of 0.1% Future Flood Risk

Policy Unit	Current risk (extent of floodplain - km^2)						Future risk (extent of floodplain - km^2) (interpolated values)						Actual incremental increase in area of floodplain			
													Future Risk 0.1% - Future Risk - 0.5%		Future Risk 0.1% - Future Risk - 1%	
	20%	10%	4%	1%	0.5%	0.1%	20%	10%	4%	1%	0.5%	0.1%	km^2	% Change	km^2	% Change
Abingdon	0.8	0.8	0.9	1.1	1.1		0.9	0.9	1.0	1.1	1.2	1.2	0.01	1%	0.03	3%
Aylesbury	0.5	0.6	0.7	0.9	1.0		0.6	0.7	0.8	1.1	1.3	1.7	0.44	35%	0.63	59%
Beam	0.7		0.9	1.4			0.8		1.2	1.6		2.4			0.80	50%
Brent	0.5		0.7	1.1			0.6		0.8	1.4		2.6			1.22	88%
Byfleet and Weybridge	1.6	1.7	1.8	2.1	2.3		1.7	1.8	2.0	2.4	2.5	2.7	0.17	7%	0.31	13%
Colne	11.9	13.2	15.1	18.2	19.9		13.4	14.9	16.9	20.4	21.2	22.0	0.78	4%	1.65	8%
Crane	1.7		3.3	4.9			2.1		3.9	5.6		8.0			2.44	44%
Graveney	0.2		0.5	0.7			0.3		0.5	0.8		1.2			0.39	51%
Guildford	0.8	0.8	0.9	0.9	0.9		0.9	0.9	0.9	1.0	1.0	1.2	0.19	19%	0.24	25%
Hogsmill	0.3		0.5	0.9			0.3		0.7	1.0		1.7			0.64	63%
Ingrebourne	2.5		4.0	5.3			3.2		4.5	5.9		8.5			2.58	44%
Kennet	15.7	16.5	17.8	20.7	21.7		16.8	18.0	20.1	22.1	22.6	23.0	0.39	2%	0.87	4%
Loddon	6.7	7.0	7.3	7.9	8.5		7.1	7.3	7.8	8.7	9.1	9.6	0.53	6%	0.90	10%
Lower Lee	4.4	5.5	7.1	12.0	14.9		5.3	6.7	9.3	15.2	16.4	17.2	0.82	5%	2.02	13%
Lower Lee tribs	0.2	0.4	0.6	1.0	1.3		0.3	0.6	0.8	1.3	1.5	2.1	0.59	39%	0.80	62%
Lower Mole	0.1	0.1	0.2	0.3	0.5		0.1	0.2	0.3	0.6	0.6	0.6	0.02	3%	0.04	7%
Lower Roding	0.2		0.3	0.7			0.2		0.4	0.8		1.6			0.82	105%
Lower Thames	19.9	25.2	32.2	43.2	49.5		27.4	33.1	40.9	51.5	52.3	53.0	0.69	1%	1.47	3%
Luton	0.0	0.0	0.1	0.1	0.3		0.0	0.0	0.1	0.3	0.4	0.7	0.29	71%	0.41	141%
Middle Lee & Stort	8.6	9.4	10.3	11.9	13.2		9.3	10.0	11.2	13.3	13.9	14.4	0.54	4%	1.15	9%
Middle Roding	0.4		0.7	1.4			0.5		0.9	1.6		2.9			1.28	79%
Oxford	2.4	3.1	4.4	6.0	7.0		3.5	4.5	5.6	7.2	7.6	7.8	0.25	3%	0.56	8%
Ravensbourne	1.0		1.4	2.3			1.2		1.8	2.8		4.8			1.97	70%
Reading	3.1	3.4	4.0	5.2	5.8		3.5	4.2	5.0	6.1	6.4	6.5	0.13	2%	0.36	6%

Policy Unit	Current risk (extent of floodplain - km^2)						Future risk (extent of floodplain - km^2) (interpolated values)						Actual incremental increase in area of floodplain			
													Future Risk 0.1% - Future Risk - 0.5%		Future Risk 0.1% - Future Risk - 1%	
	20%	10%	4%	1%	0.5%	0.1%	20%	10%	4%	1%	0.5%	0.1%	km^2	% Change	km^2	% Change
Rural Wey	8.2	8.6	9.0	9.6	10.0		8.7	9.1	9.5	10.2	10.5	11.2	0.71	7%	1.03	10%
Sandford to Cookham	26.6	32.5	39.1	50.5	57.1		34.5	40.1	48.1	58.7	60.0	61.0	0.98	2%	2.31	4%
Thame	15.6	16.6	17.6	19.2	19.9		16.8	17.6	18.8	20.4	21.2	23.0	1.77	8%	2.63	13%
Upper Lee	1.3	1.4	1.5	1.7	1.9		1.3	1.4	1.6	1.9	2.0	2.0	0.05	3%	0.13	7%
Upper Roding	8.1		9.8	11.5			8.7		10.6	12.3		14.8			2.50	20%
Upper Thames	73.8	78.4	84.3	91.8	95.3		79.9	84.7	90.3	96.8	99.2	104.0	4.82	5%	7.20	7%
Wandle	1.1		1.4	2.1			1.2		1.8	2.4		3.4			1.02	43%
Windsor & Maidenhead	6.4	8.2	11.3	20.2	24.9		9.2	12.0	18.3	26.1	26.8	27.3	0.48	2%	1.23	5%

Table 4.6 Extreme future flood event calculations

Infrastructure

Table 4.7 and Table 4.8 list the vulnerable infrastructure within the 10% AEP and also the 1% AEP fluvial floodplain, as a result of climate change, using MDSF data where available. Comparing these results to those presented for the baseline in Chapter 3 (Table 3.9 and 3.10), climate change results in many more vulnerable infrastructure being at risk from fluvial flooding.) In particular there is a large increase in the number of schools, emergency response and power and gas stations at risk as a result of climate change.

Some key observations are:

- A hospital in the Reading policy unit is within the 1% AEP (there were previously none at risk across the whole region)
- The number at schools within the 1% AEP in the Lower Thames increases from 1 to 8. The total increase at a regional level is 133% for the 1% AEP event (from 6 schools to 14).
- The number of emergency response centres within the 1% AEP floodplain in the Windsor and Maidenhead policy unit increases from 0 to 3
- The number of power and gas stations within the 0.1% AEP floodplain increases from 47 to 60 in the Lower Lee, 40 to 63 in the Lower Thames, 12 to 23 in Reading and 6 to 16 in Windsor and Maidenhead. The total for the region increases by 56% for the 1% AEP event and 38% for the 0.1% AEP.
- The number of railway stations in the 1% AEP floodplain across the region increases from 9 to 13
- No prisons, chalet home parks or airports are at risk (recognising however that the MDSF data does not cover the whole region)

Policy Unit	High Vulnerability																	
	Hospital		School		Care Home		Prison		Mobile or Chalet Home Park		Camping/ Caravan Site		Emergency Response[11]		Power & Gas Stations		Telephone Exchange	
	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP
Abingdon	0	0	1	1	1	1	0	0	0	0	0	0	1	2	3	3	0	0
Addlestone Bourne, Emm Brook and The Cut																		
Aylesbury	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0
Basingstoke																		
Beam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Beverley Brook	0	0	0	7	0	0	0	0	0	0	0	0	0	1	0	19	0	0
Brent	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	8	0	0
Byfleet and Weybridge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0
Colne	0	0	0	3	1	1	0	0	0	0	0	0	0	0	13	24	0	0
Colne tributaries and Wye																		
Crane	0	1	0	5	0	1	0	0	0	0	0	0	0	0	0	8	0	0
Graveney	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	4	0	0
Guildford	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1	1	0	0
Hoe Stream																		
Hogsmill	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	2	0	0
Ingrebourne	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	5	0	1
Kennet	0	0	0	0	0	0	0	0	0	0	0	0	1	1	6	14	0	0
Loddon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0
Lower Lee	0	0	2	7	0	2	0	0	0	0	0	0	0	0	7	60	0	0
Lower Lee tributaries	0	0	1	4	0	1	0	0	0	0	0	1	0	3	3	11	0	0
Lower Mole	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0
Lower Roding	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
Lower Thames	0	0	8	20	1	5	0	0	0	0	3	3	1	7	23	63	1	2
Luton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Middle Lee and Stort	0	0	0	1	1	1	0	0	0	0	1	1	0	0	0	2	0	0
Middle Mole																		
Middle Roding	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	15	0	0
Ock																		

[11] This includes ambulance stations, fire stations and police stations

Oxford	0	1	0	3	0	0	0	0	0	0	0	0	0	0	2	11	0	0
Pinn																		
Ravensbourne	0	1	0	7	0	1	0	0	0	0	0	0	0	2	0	20	0	0
Reading	1	1	0	3	0	0	0	0	0	0	0	0	2	2	8	23	0	0
Rural Wey	0	0	0	0	1	1	0	0	0	0	0	0	1	1	1	1	0	0
Sandford to Cookham	0	0	1	1	3	5	0	0	0	0	0	1	0	0	1	10	0	0
Swindon																		
Thame	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper and Middle Blackwater																		
Upper Lee	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Upper Mole																		
Upper Roding	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Upper Thames	0	0	1	2	0	0	0	0	0	0	2	2	1	1	5	6	0	1
Wandle	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	14	0	0
Windsor and Maidenhead	0	1	0	7	1	4	0	0	0	0	0	1	0	3	2	16	0	0
TOTAL	**1**	**5**	**14**	**76**	**10**	**26**	**0**	**0**	**0**	**0**	**6**	**9**	**8**	**32**	**84**	**360**	**1**	**4**

Table 4.7 Highly vulnerable infrastructure within the 10% and 1% AEP fluvial floodplain (MDSF)

Policy Unit	**Lower Vulnerability**									
	Airport		Railway Station		IPPC Sites[12]		Radioactive[13]		Sewage & Water Treatment	
	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP
Abingdon	0	0	0	0	0	0	0	0	0	0
Addlestone Bourne, Emm Brook and The Cut										
Aylesbury	0	0	1	1	0	0	0	0	0	1
Basingstoke										
Beam	0	0	0	0	0	0	0	0	0	0
Beverley Brook	0	0	0	1	0	0	0	0	0	0
Brent	0	0	0	0	0	0	0	0	0	0
Byfleet and Weybridge	0	0	0	0	0	0	0	0	0	1
Colne	0	0	0	0	0	1	0	0	0	0
Colne tributaries and Wye										
Crane	0	0	0	1	0	0	0	0	0	0
Graveney	0	0	0	0	0	0	0	0	0	0
Guildford	0	0	0	0	0	0	0	0	0	0
Hoe Stream										
Hogsmill	0	0	0	0	0	0	0	0	0	0
Ingrebourne	0	0	0	0	0	0	0	0	0	2
Kennet	0	0	1	1	1	1	1	1	0	1
Loddon	0	0	0	1	1	1	0	1	1	1
Lower Lee	0	0	0	2	0	3	0	0	0	1
Lower Lee tributaries	0	0	0	0	0	0	0	0	0	0
Lower Mole	0	0	1	1	0	0	0	0	0	0
Lower Roding	0	0	0	1	0	0	0	0	0	0
Lower Thames	0	0	0	3	1	3	0	1	1	1
Luton	0	0	0	0	0	0	0	0	0	0
Middle Lee and Stort	0	0	4	4	0	0	0	0	0	0
Middle Mole										
Middle Roding	0	0	0	0	0	0	0	0	0	0
Ock										
Oxford	0	0	0	0	0	0	0	0	0	0
Pinn										
Ravensbourne	0	0	0	2	0	0	0	2	0	0
Reading	0	0	0	0	0	0	0	0	0	0
Rural Wey	0	0	0	0	0	0	0	0	4	4
Sandford to Cookham	0	0	1	3	0	1	0	0	4	6
Swindon										
Thame	0	0	0	0	0	0	0	0	1	1
Upper and Middle Blackwater										
Upper Lee	0	0	0	0	0	0	0	0	1	2
Upper Mole										
Upper Roding	0	0	0	0	0	0	0	0	0	3
Upper Thames	0	0	1	2	1	2	0	0	3	3
Wandle	0	0	0	0	0	0	0	1	0	0
Windsor and Maidenhead	0	0	0	0	0	1	0	1	1	2
TOTAL	**0**	**0**	**9**	**23**	**4**	**13**	**1**	**7**	**16**	**29**

Table 4.8 Less vulnerable infrastructure within the 10% and 1% AEP fluvial floodplain (MDSF)

[12] Integrated Pollution Prevention and Control (IPPC) sites includes major landfill, hazardous waste treatment and incineration plants

[13] Sites with radioactive substances (RAS)

Regarding the possible impacts of future scenarios on people and property, we have concluded that when forming policy:

- **climate change is potentially the most significant driver of future flood risk**
- **the main impact from large scale floods across the region would be to increase the number of people exposed to flooding. However, this would tend to be flooding of a relatively shallow depth and in areas where adequate warning could be provided;**
- **climate change does increase the risks to people, but does not significantly change the spatial distribution of the current risk;**
- **we need to look further at the exposure of vulnerable people to flooding from thunderstorms in our urban areas, which is potentially one of the largest impacts of climate change. We will consider this in broad terms in our policy appraisal.**

4.5.3 Flood risk to the environment

In the previous chapter we concluded that:

- there are very few designated sites that would influence policy. However, our analysis has shown that most of the water dependent sites need the existing hydrological regime to be maintained or the frequency and length of inundation from flooding to be increased;
- the main risk to the environment would be ignoring the opportunity to identify landscape-scale improvements and the potential to restore the floodplain and river environments. Achieving this would help us to progress by aligning flood risk management with BAP and Water Framework Directive objectives, where possible.

The future scenarios point to an increasing risk of flooding with more regular inundation of the floodplain and, in some cases, deeper flooding. This is not necessarily detrimental to the natural environment (unlike many other indicators, for example properties at risk and economic damages). In some circumstances, it may be desirable. It is important to base our analysis on an understanding of what currently exists within the floodplain environment and how it may be affected by future changes to flooding.

Table 4.9 indicates the increase in the number and area of designated sites within the floodplain as a result of climate change.

Policy Unit	SSSIs						SACs						SPAs					
	10% AEP			1% AEP			10% AEP			1% AEP			10% AEP			1% AEP		
	Count	Area	% increase in area	Count	Area	% increase in area	Count	Area	% increase in area	Count	Area	% increase in area	Count	Area	% increase in area	Count	Area	% increase in area
Abingdon	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0.000	0.00%	0	0.000	0.00%
Addlestone Bourne, Emm Brook, The Cut																		
Aylesbury	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0.000	0.00%	0	0.000	0.00%
Basingstoke																		
Beam				0	0	0.00%				0	0	0.00%				0	0.000	0.00%
Beverley Brook																		
Brent				2	0.022	0.00%				0	0	0.00%				0	0.000	0.00%
Byfleet and Weybridge	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0.000	0.00%	0	0.000	0.00%
Colne	5	1.848	19.46%	5	2.355	6.42%	0	0	0.00%	0	0	0.00%	1	0.010	233.33%	1	0.025	78.57%
Colne tributaries and Wye																		
Crane				0	0	0.00%				0	0	0.00%				0	0.000	0.00%
Graveney				0	0	0.00%				0	0	0.00%				0	0.000	0.00%
Guildford	1	0.017	30.77%	1	0.019	0.00%	0	0	0.00%	0	0	0.00%	0	0.000	0.00%	0	0.000	0.00%
Hoe Stream																		
Hogsmill	0	0		0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0.000	0.00%	0	0.000	0.00%
Ingrebourne				2	3.105	12.26%				0	0	0.00%				0	0.000	0.00%
Kennet	5	0.721	21.18%	6	0.957	8.01%	2	0.254	31.61%	2	0.339	13.76%	0	0.000	0.00%	0	0.000	0.00%
Loddon	1	0.005	25.00%	1	0.005	0.00%	0	0	0.00%	0	0	0.00%	0	0.000	0.00%	0	0.000	0.00%
Lower Lee	6	1.823	15.60%	6	2.425	9.68%	0	0	0.00%	0	0	0.00%	1	1.424	59.82%	1	1.425	6.66%
Lower Lee tributaries	1	0.004	33.33%	1	0.032	88.24%	1	0.003	50.00%	1	0.018	50.00%	1	0.010	n/a	1	0.010	0.00%
Lower Mole	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0.000	0.00%	0	0.000	0.00%
Lower Roding				0	0	0.00%				0	0	0.00%				0	0.000	0.00%
Lower Thames	7	2.546	4.60%		2.712	1.88%	0	0	0.00%	0	0	0.00%	1	1.540	3.22%	1	1.622	1.50%
Luton	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0.000	0.00%	0	0.000	0.00%
Middle Lee and Stort	6	0.727	5.06%	6	1.102	8.15%	0	0	0.00%	0	0	0.00%	1	0.550	126.34%	1	0.582	18.53%
Middle Mole																		
Middle Roding				0	0	0.00%				0	0	0.00%			0.00%	0	0.000	0.00%
Ock																		
Oxford	5	0.923	36.14%	5	1.125	5.63%	1	0.491	31.28%	1	0.655	7.55%	0	0.000	0.00%	0	0.000	0.00%
Pinn																		
Ravensbourne				0	0	0.00%				0	0	0.00%				0	0.000	0.00%

Reading	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0.000	0.00%	0	0.000	0.00%
Rural Wey	5	1.114	7.32%	5	1.227	5.23%	1	0.001	0.00%	1	0.001	0.00%	1	0.001	0.00%	1	0.008	700.00%
Sandford to Cookham	7	0.286	6.72%	7	0.318	6.35%	3	0.049	32.43%	3	0.072	20.00%	0	0.000	0.00%	0	0.000	0.00%
Swindon																		
Thame	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0.000	0.00%	0	0.000	0.00%
Upper and Middle Blackwater																		
Upper Lee	1	0.017	0.00%	1	0.032	6.67%	0	0	0.00%	0	0	0.00%	1	0.032	88.24%	1	0.032	6.67%
Upper Mole																		
Upper Roding				1	0.178	2.30%	0	0	0.00%	0	0	0.00%	0	0.000	0.00%	0	0.000	0.00%
Upper Thames	13	2.931	26.83%	13	3.186	2.64%	1	1.747	50.47%	1	1.913	2.52%	0	0.000	0.00%	0	0.000	0.00%
Wandle				0	0	0.00%				0	0	0.00%				0	0.000	0.00%
Windsor and Maidenhead	2	0.063	133.33%	2	0.102	0.00%	0	0	0.00%	0	0	0.00%	0	0.000	0.00%	0	0.000	0.00%

Table 4.9 Increase in the number and area of designated sites in the 10% and 1% AEP floodplain as a result of climate change

Analysis of the Thames region natural floodplain shows that there is scope to accommodate an increase in the frequency of flooding in some locations. It also shows that in some cases this can be used to improve the scale or condition of habitats and species within the floodplain environment. The requirements of the water dependent internationally designated sites within the floodplain show that an increased likelihood of flooding can have a beneficial effect. For the majority of the sites it will create opportunities to improve both resilience and habitat extent.

Our policy appraisal is based upon maximising these opportunities. This can be achieved through understanding both the potential impacts of flooding and the needs and future requirements of the floodplain environment.

In Chapter 3 we saw that, in some cases, the current conditions and hydrological regime are favourable and we will need to build this into our policy decisions. However, on the whole, more regular flooding should lead to an improved natural environment, though locally we may need some controls on the nature of this flooding (e.g. not too deep or fast flowing). We need to remember that even with an increasing likelihood of flooding, the impact of any flood risk activity and flooding event will be the exception, rather than the rule.

The critical link that we have been able to make through our analysis is that more regular flooding of the current floodplain environment provides real opportunities. In most parts of the catchment, this is the most effective way of sustaining the existing level of risk or providing future reductions in flood risk to economic and social receptors. Clearly, this cannot happen everywhere. But, as we saw in Chapter 3, most of our floodplain is natural. Preserving and enhancing our use of the floodplain will be an effective and sustainable way of managing flood risk.

This link is one of the underlying factors in our policy appraisal and action plan presented in Chapters 6 and 7. Here we will show where this link is most effectively utilised (policy) and how it will be developed (Action Plan).

4.4 Flood risk at key locations

Policy Unit	Social		Economic				Environment		
	No. of People	% with SFVI of 4 or 5	No. of Properties	Damages (£M)	Vulnerable Infrastructure		Area of Designated Sites (km2)		
					High	Lower	SSSI	SAC	SPA
Abingdon	4318	57.4%	1919	77.03	7	0	0	0	0.000
Addlestone Bourne, Emm Brook and The Cut									
Aylesbury	5578	48.6%	2479	63.81	3	1	0	0	0.000
Basingstoke									
Beam	1296	30.6%	576	11.51	2	0	0	0	0.000
Beverley Brook									
Brent	7067	38.7%	3141	130.80	10	0	0.022	0	0.000
Byfleet and Weybridge	2351	11.8%	1045	46.81	3	1	0	0	0.000
Colne	17377	23.0%	7723	520.87	28	1	2.355	0	0.025
Colne tributaries and Wye									
Crane	19348	17.3%	8599	253.20	15	1	0	0	0.000
Graveney	9545	30.4%	4242	102.11	7	0	0	0	0.000
Guildford	2187	31.4%	972	118.82	4	0	0.019	0	0.000
Hoe Stream									
Hogsmill	3479	38.9%	1546	42.60	4	0	0	0	0.000
Ingrebourne	2617	53.7%	1163	137.12	7	2	3.105	0	0.000
Kennet	7567	28.3%	3363	140.81	15	4	0.957	0.339	0.000
Loddon	1296	18.4%	576	18.27	3	4	0.005	0	0.000
Lower Lee	56088	99.9%	24928	1268.28	69	6	2.425	0	1.425
Lower Lee tributaries	18281	48.2%	8125	243.03	20	0	0.032	0.018	0.010
Lower Mole	1996	1.1%	887	36.41	2	1	0	0	0.000
Lower Roding	956	33.6%	425	22.77	5	1	0	0	0.000
Lower Thames	72506	14.7%	32225	1690.20	100	8	2.712	0	1.622
Luton	2642	65.2%	1174	10.36	0	0	0	0	0.000
Middle Lee and Stort	6536	14.6%	2905	137.90	5	4	1.102	0	0.582
Middle Mole									
Middle Roding	6264	83.3%	2784	105.49	17	0	0	0	0.000

Ock									
Oxford	14252	65.5%	6334	295.20	15	0	1.125	0.655	0.000
Pinn									
Ravensbourne	17188	32.6%	7639	246.62	31	4	0	0	0.000
Reading	11855	18.3%	5269	424.83	29	0	0	0	0.000
Rural Wey	1456	8.7%	647	31.50	3	4	1.227	0.001	0.008
Sandford to Cookham	15156	32.1%	6736	334.15	17	10	0.318	0.072	0.000
Swindon									
Thame	349	44.5%	155	7.52	0	1	0	0	0.000
Upper and Middle Blackwater									
Upper Lee	1199	34.7%	533	40.06	2	2	0.032	0	0.032
Upper Mole									
Upper Roding	3967	34.8%	1763	61.47	1	3	0.178	0	0.000
Upper Thames	9846	34.5%	4376	197.57	12	7	3.186	1.913	0.000
Wandle	15482	28.4%	6881	505.68	17	1	0	0	0.000
Windsor and Maidenhead	26620	18.4%	11831	426.91	32	3	0.102	0	0.000
TOTAL	366662	39.6%	162961	7749.71	485	69	18.902	2.998	3.704

Table 4.10 Summary of flood risk for the 1% AEP event under the climate change scenario (using MDSF data)