

## **SOUTH EAST ENGLAND PARTNERSHIP BOARD REGIONAL CLIMATE CHANGE VULNERABILITY ASSESSMENT**

3 February 2010

### **Executive Summary**

The aim of this assessment is to identify climate change vulnerability 'hotspots' in the region to inform the future distribution of growth and the prioritisation of adaptation<sup>1</sup> measures in the Regional Strategy. As the consideration of climate change vulnerability is a new requirement for regional planning and there is little guidance / good practice available yet, the approach to this is of an experimental nature.

At its centre is the investigation of vulnerability by identifying and mapping geographic variation in current socio-economic factors which enhance (make worse) vulnerability within the region.

Flooding is the most significant issue related to climate change impacts in the region. The risk of surface water flooding in urban areas may increase in particular in the light of more torrential and frequent rainfall events especially during winter and the risk of tidal flooding is likely to be affected by sea level rise. Whilst our Regional Flood Risk Appraisal focused on future growth, this Regional Climate Change Vulnerability Assessment aims to identify existing developed areas, infrastructure, services, etc within the region that are particularly vulnerable, additional climate impacts such as droughts and heat waves are also considered.

Areas that are likely to be particularly vulnerable to flooding combine flood risk with low average earnings and high levels of deprivation<sup>2</sup>, examples include; Portsmouth and Eastbourne as well as the rural coastal authority of Swale. Urban areas in the North West of Surrey such as Spelthorne and Elmbridge are also comparatively vulnerable to increasing flood risk but could in addition experience urban heat more extremely than other parts of the region.

However, the basis for the above identification of areas which may be particularly vulnerable to climate change impacts is tentative and requires further development. Their level of detail does not allow us to draw conclusions without further investigations at the local level and many assumptions are underlying the few datasets available.

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<sup>1</sup> Adaptation represents measures to minimise the adverse effects of climate change and take advantage of any benefits.

<sup>2</sup> This may make it difficult for households to cope if they are expected to fund them or residents are less able to relocate.

## 1. Introduction

- 1.1 The aim of this assessment is to identify climate change vulnerability 'hotspots' in the region to inform the future distribution of growth and the prioritisation of adaptation measures in the Regional Strategy.
- 1.2 The recently published UK climate change projections<sup>3</sup> confirm that the South East of England is forecast to experience major climatic change over the coming century including:<sup>4</sup>
- Gradually increasing mean temperatures: + 3.9°C (but up to + 6.5°C possible) in summer (+ 3.0°C in winter)
  - More intense heat (heat waves): + 5.3°C daily maximum temperature (but up to + 9.2°C possible)
  - Longer periods without rain (drought): - 23% in summer mean precipitation (but up to - 48% possible)
  - More intense rain: + 22% in winter mean precipitation (but up to + 51% possible)
  - Sea level rise + 36.3 cm (for London on 1990 basis)
- 1.3 Vulnerability is the degree of exposure to a change/event taking into account the sensitivity to its impacts and the time/capacity to react. The probable vulnerability of people/assets/locations is one aspect of risk – alongside the probability of a change/event itself and its consequences (who and what is affected).<sup>5</sup>
- 1.4 The Climate Change PPS<sup>6</sup> requires regional planning bodies to consider the implications of climate change on the built development, infrastructure and services and biodiversity. On this basis the scale, nature and location of potential adaptation measures to reduce existing and future vulnerabilities should be identified. This should inform regional and local policy making. The regional assessment can also provide a framework for the more detailed assessments required at local level and inform the regional element of the national Climate Change Risk Assessment (CCRA), which has just been commissioned, and will be completed in 2011.

## 2. Methodology

- 2.1 There is no established guidance on how to undertake a regional vulnerability assessment required under PPS. A few English regions

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<sup>3</sup> See <http://ukclimateprojections.defra.gov.uk> for further details.

<sup>4</sup> Based on a medium-emissions scenario and central estimate for 2080. The central estimate is used to provide a broad context and a contrast to the extremes in brackets.

<sup>5</sup> Draft London Adaptation Strategy, 2008– see <http://www.london.gov.uk/mayor/publications/2008/08/climate-change-adapt-strat.jsp>

<sup>6</sup> See <http://www.communities.gov.uk/publications/planningandbuilding/ppsclimatechange>

have recently taken initial steps that may contribute towards meeting the specific requirement of the PPS. In Yorkshire and Humber and the North East a Climate Change Adaptation Study has been completed outlining impacts at different levels<sup>7</sup> In the South West consultants have done a preliminary investigation into the vulnerability of a wide range of sectors to extreme weather events and proposed a basic methodology to map vulnerabilities. The Mayor of London published a draft Climate Change Adaptation Strategy for consultation in August 2008, which is based on investigations into the vulnerability of public health, the environment, the economy and the infrastructure of the capital.<sup>8</sup>

- 2.2 The Partnership Board is taking its first steps building on existing study results in particular in the field of water management involving experts from a wide range of sectors, local authorities and also stakeholders abroad. Initial feedback from stakeholders on our approach has been very encouraging. Vulnerability focussed, starting with here and now rather than distant and uncertain future perhaps, need to be clear.
- 2.3 Based on a review of mostly climate change impact studies the impacts of climate change on the following sectors are being investigated. The sectors allow a relatively comprehensive coverage of a wide range of impacts. The coverage of some sectors may be expanded if relevant data become available:
- Population – covering health and vulnerable groups
  - Natural Resources – covering water supply, quality and infrastructure, biodiversity, landscape and heritage
  - Built Environment – covering mainly residential properties
  - Infrastructure – covering transport and services (health/care, education)
  - Economic Development – covering key business sectors and employment sites
- 2.4 The aim and particularly innovative aspect of this research is to go beyond generic/obvious impacts of climate change and investigate vulnerability by identifying and mapping geographic variation in current socio-economic factors which enhance (make worse) vulnerability within the region. This will necessarily be done through the identification of indicators. For the above sectors we are exploring the following questions:
- What factors enhance vulnerability to current and future climatic change and variability?

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<sup>7</sup> See <http://www.adaptyh.co.uk> and <http://www.adaptne.org>

<sup>8</sup> Draft London Adaptation Strategy, 2008 Annex 1 provides an initial overview of good practice from elsewhere.

- What consequences<sup>9</sup> are currently experienced as a result of climate variability (extreme weather)?
  - Where are the potential hotspots where areas of high vulnerability correspond to areas of high climate impact 'risk'?
- 2.5 Some key answers to these questions are highlighted in the following chapter. Issues and indicators have been identified to illustrate the vulnerabilities/consequences spatially, focusing on those, which are expected to accelerate significantly through climatic change as set out in para 1.1. The scale of this could be informed by the UK climate projections, once more refined issues/indicators are available which correlate directly with the climate projection data. It should be noted that the initially used indicators are influenced by a wide range of non-climatic factors. All findings in terms of geographic variation require further investigation at the local level.
- 2.6 The intention is to compare/overlay maps for different indicators in order to identify 'vulnerability hotspots'. This should then inform the development of spatial options in the Regional Strategy and help to prioritise the type and distribution of adaptation measures required.

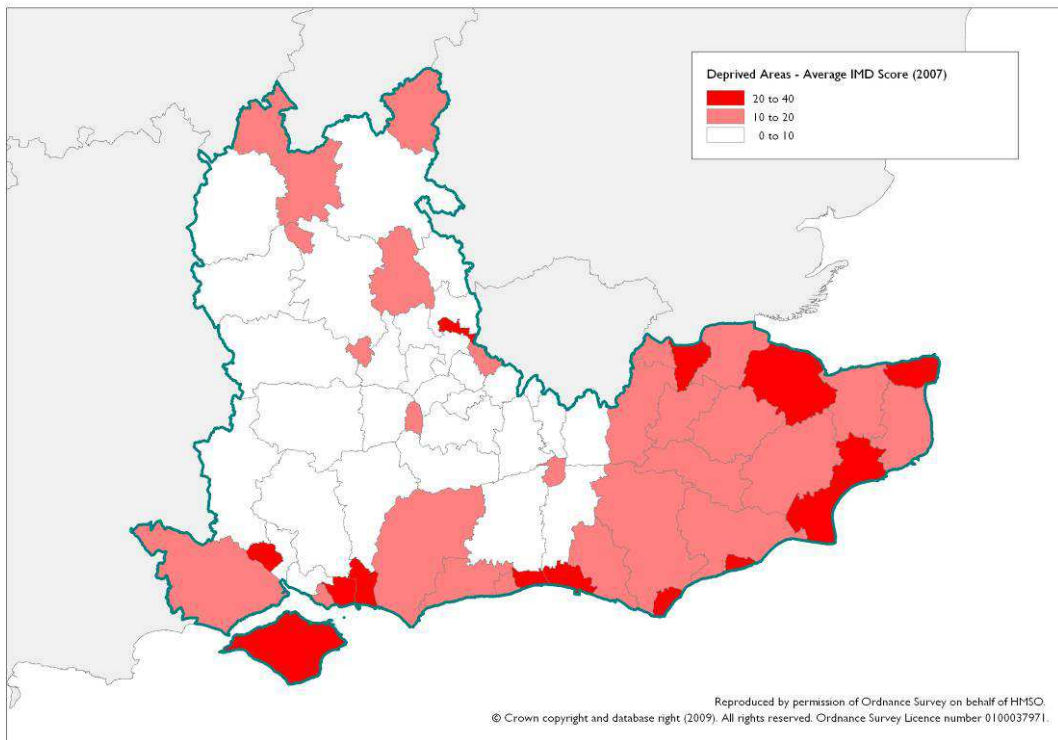
### 3. Initial Findings

#### Population

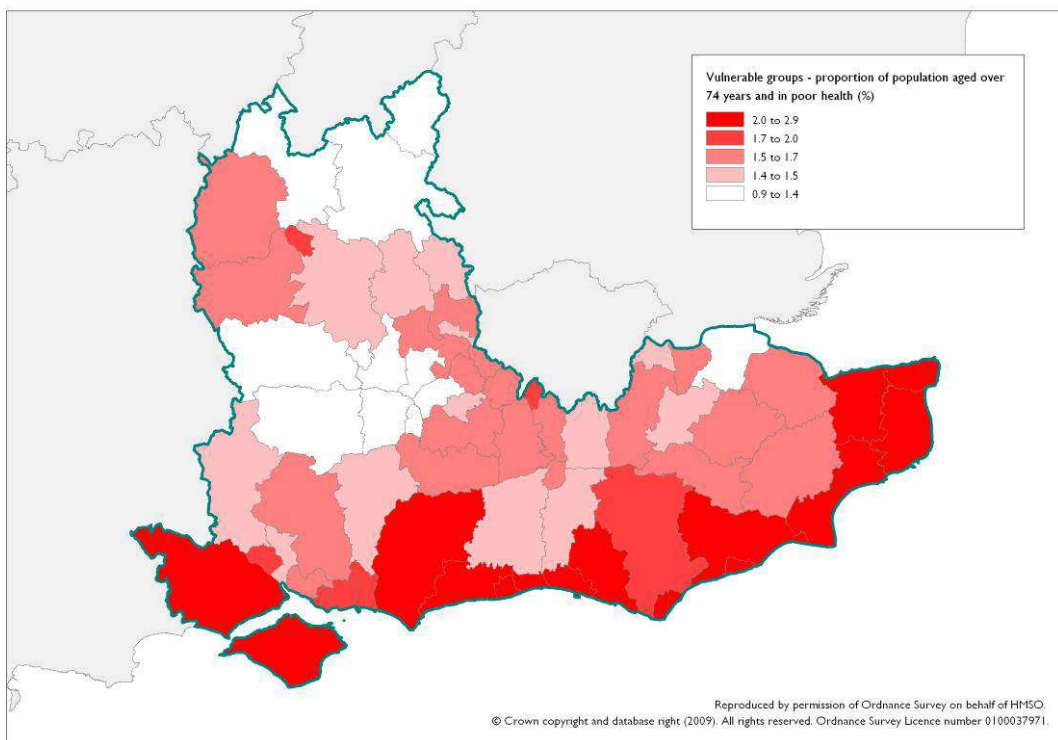
- 3.1 Climate change is likely to have the greatest impact on the most **vulnerable groups** in society such as old and young, chronically ill, socially excluded and deprived, refugees and immigrants as they may have insufficient means to adapt. Map 1 for example highlights that urban areas along the coast have a high proportion of deprived communities. And Map 2 shows that in almost all coastal authorities the proportion of old people in poor health is comparatively high.

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<sup>9</sup> These are of interest, as the future vulnerability may be greater where e.g. the damage to assets and human health from past weather events has been more significant.

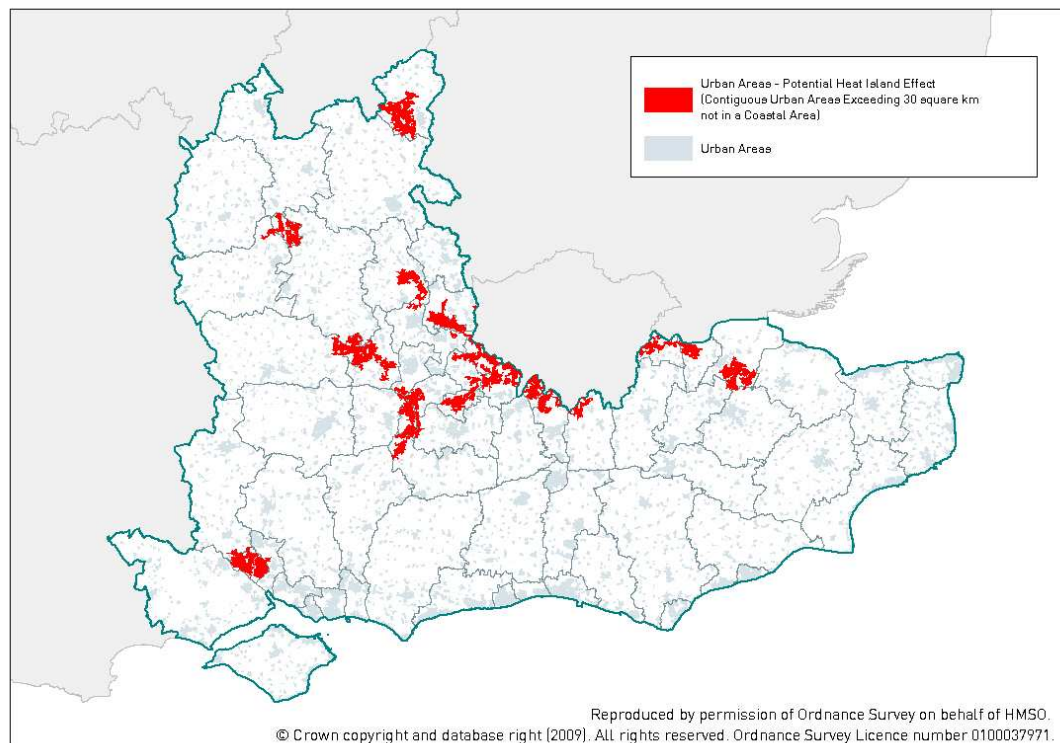


**Map 1** : Deprived areas – fewer opportunities for residents to adapt to climate impacts



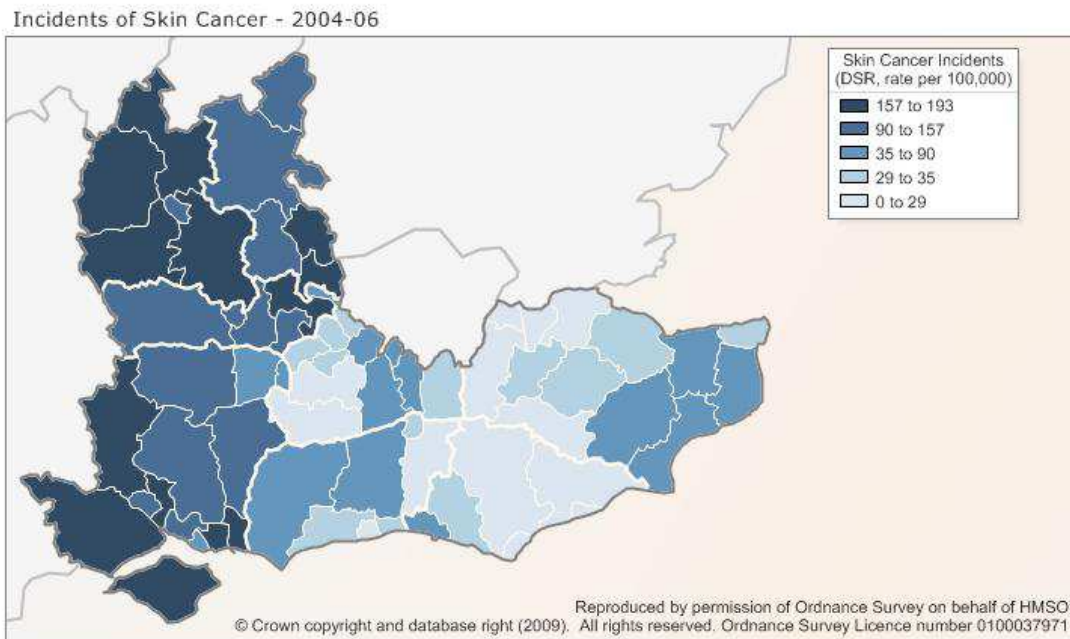
**Map 2** : Old people in poor health – particularly vulnerable to severe weather events and potentially less able to adapt

- 3.2 Different parts of the region have recently experienced heat waves (in particular in 2003). Heat waves are most uncomfortable in **dense urban areas** with little green space and flowing water (rivers, the sea). Map 3 highlights that for example parts of the London Fringe and the Blackwater Valley are particularly urbanised and therefore potentially more vulnerable to heat waves, although some of these urban areas may be very green and have a low density. The risk rating of the Community Risk Registers rates the risk of heat waves as high for most parts of the regions except Hampshire and Kent. A review of urban density vs urban green/blue space and the promotion of adaptation of development (e.g. ventilation, shading) in the light of more frequent urban heat could help to address this vulnerability.



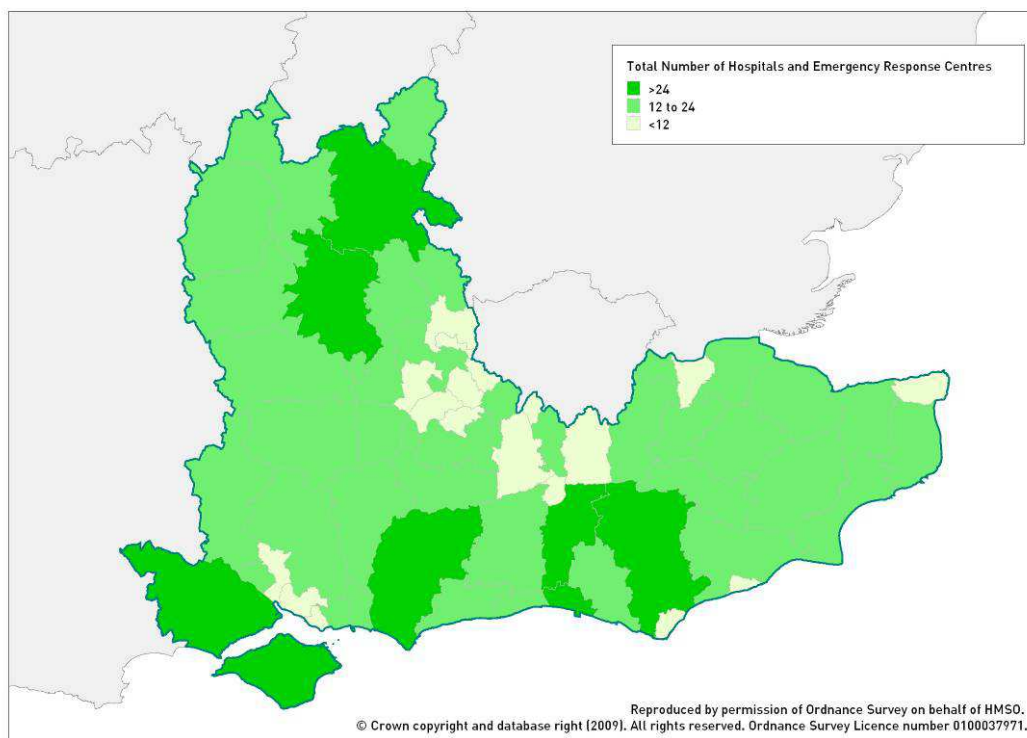
**Map 3** : Contiguous urban areas – greatest risk of uncomfortable urban heat due to potential lack of blue/green space

- 3.3 Whilst a hotter climate is likely to significantly reduce cold-related health problems, it may also increase the risk of **heat-related diseases** such as sunburn, heat stroke, skin cancer, food poisoning and water-borne disease. Map 4 shows that in the west of the region (Oxfordshire and West Hampshire) the highest number of skin cancer cases occurred between 2004 and 2006. More severe and frequent heat could also worsen air quality, and therefore asthma, respiratory diseases and allergic reactions. Most of the region's current Air Quality Management Areas are around the M25. Climate change could exacerbate these heat-related problems.



**Map 4 :** Skin cancer – might indicating greater exposure to sunlight as one potential consequence of hot weather

- 3.4 An extreme weather event could lead to an overwhelming demand on **health services** in the affected area. And in addition to physical illnesses/injuries flooding in particular can also lead to significant psychological stress. Map 5 indicates that a range of mainly urban areas in particular in Surrey have a comparatively low number of hospitals and Emergency Response Centres. However, a range of locally important health facilities are not captured by this and the mapped services might be located in border areas benefiting neighbouring authorities. It may still be useful to review of the provision/distribution of health services to deal with potential casualties of more frequent severe weather.

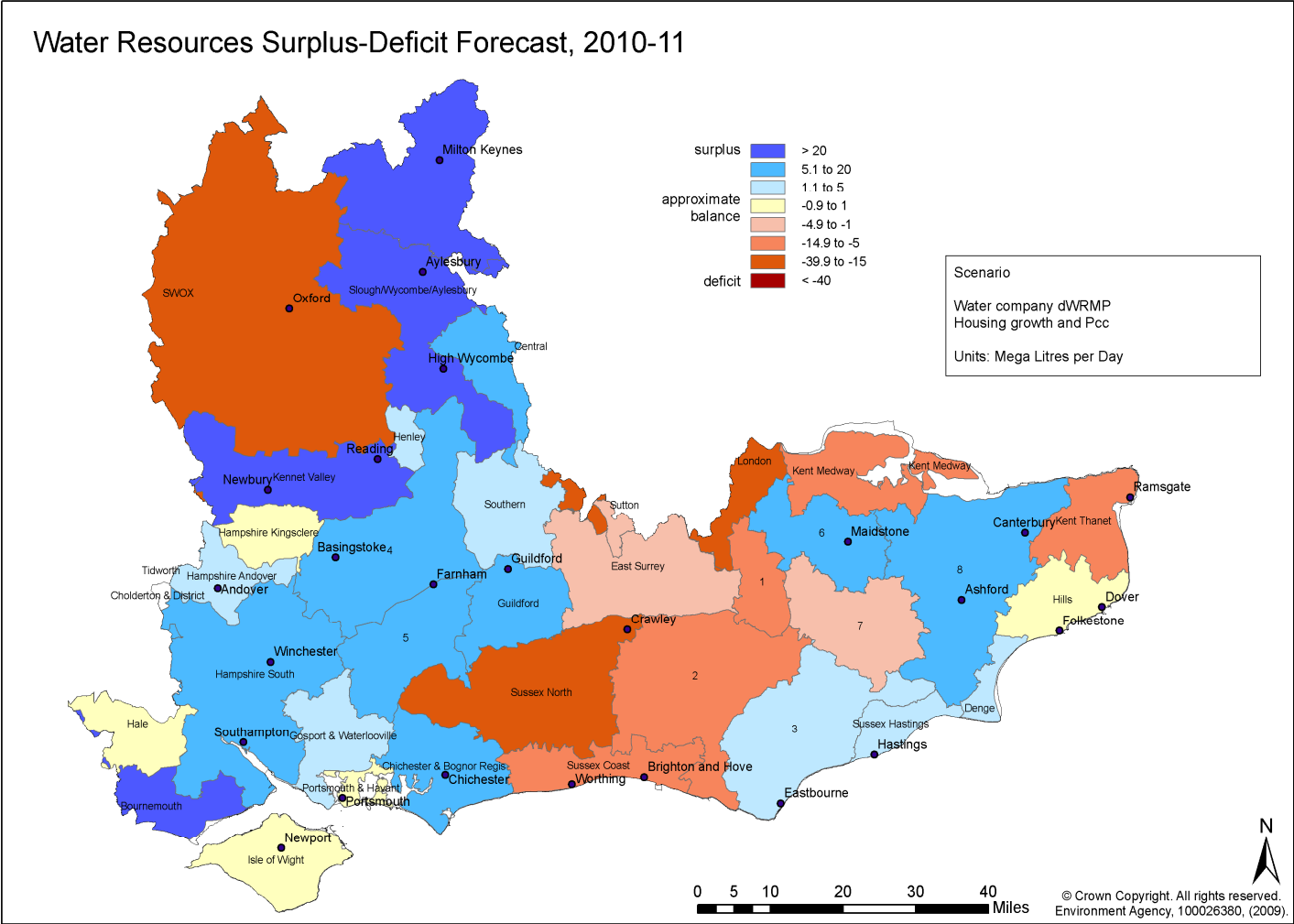


**Map 5** : Provision of hospitals and Emergency Response Centres – a lack in provision could indicate capacity problems to deal with casualties of a severe weather event

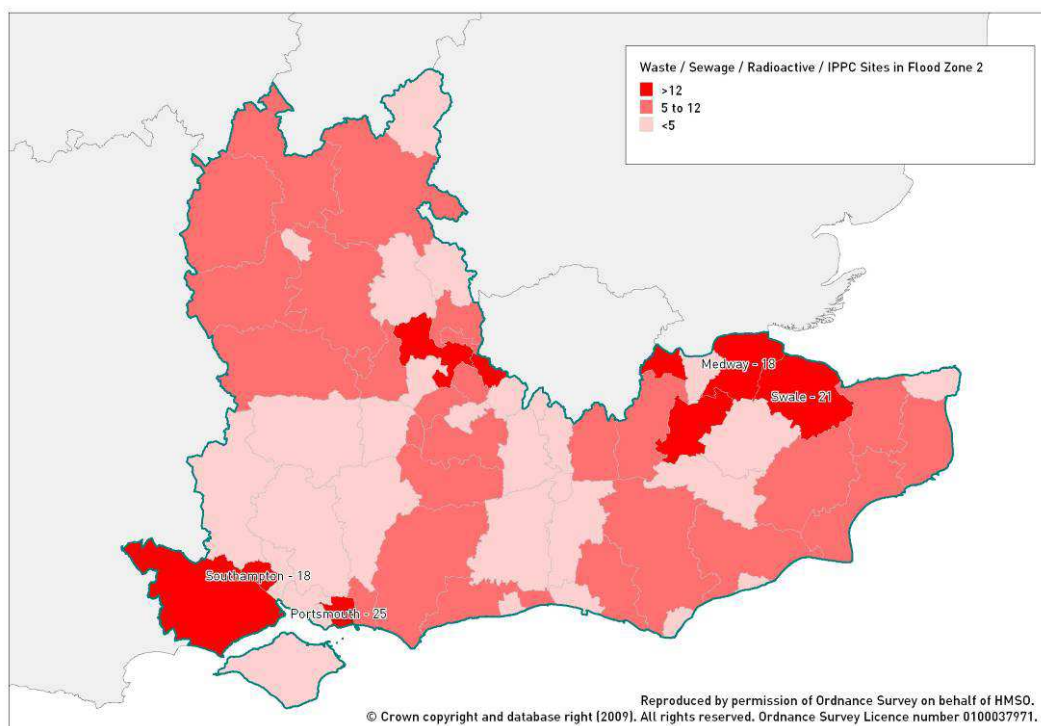
## Natural Resources

- 3.5 Climate change is likely to lead to more frequent droughts and heat waves in summer and therefore to reduced **water availability** and increased demand at peak times. The risk rating of the Community Risk Registers rates the risk of droughts very high for Kent and only medium for Hampshire. Alongside other drivers such as future water consumption levels and the tightening environmental standards, the impacts of climate change may require significant additional investment to secure future supply. The Environment Agency's water resource modelling has established the water surplus-deficit for each Water Resource Zone for a range of scenarios using data from water companies' water resources planning. More frequent droughts could exacerbate the situation in potential deficit areas such as Oxfordshire. Whilst schemes are underway/planned to restore the balance, they require investment and new supply options could potentially have negative impacts on the environment. The model makes allowances for these climate change impacts, but the scale and geographic variation require further investigation.
- 3.6 More frequent droughts during summer could also lead to low river flows with implications for **water quality** beyond those related to growth that are being investigated through the Environment Agency's water quality modelling. The risk of flooding of contaminated sites and waste management sites is another potentially increasing threat to water quality. Map 7 shows that Portsmouth and Southampton as well as Swale and Medway have the highest number of such sites in areas of flood risk. Flood protection for sites at risk should be reviewed.

**Map 6:** Water resource supply-demand balance<sup>10</sup> - more frequent droughts could exacerbate this situation

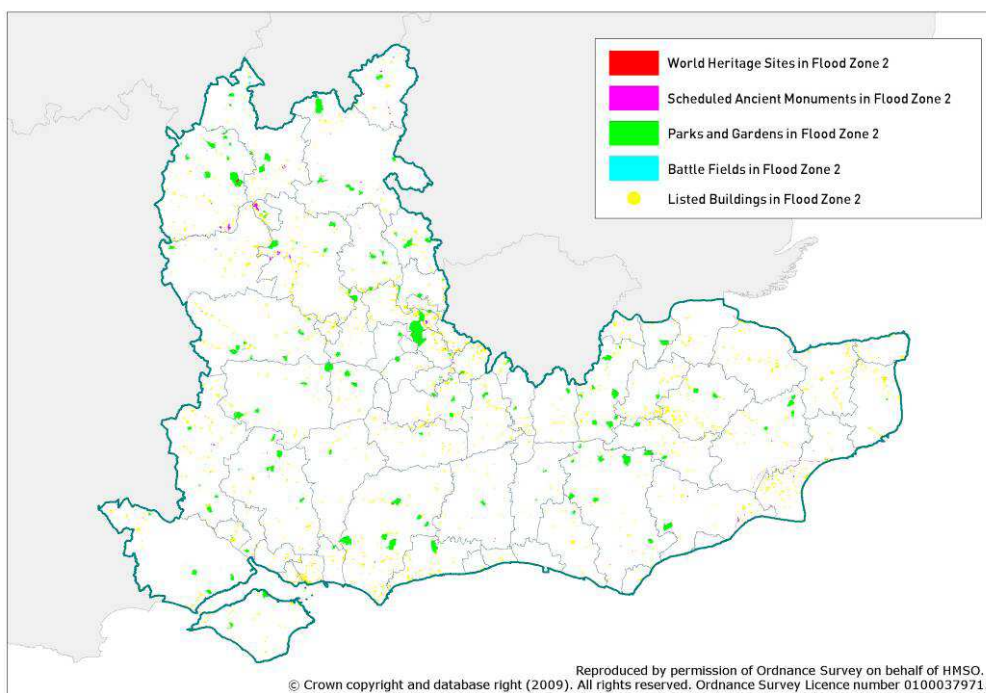


<sup>10</sup> based on water companies' draft Water Resource Management Plans



**Map 7** : Contaminated sites in Flood Zone 2 – the flooding of such sites could threaten water quality

- 3.7 Climate change may drive the migration of some **species** within and beyond the South East as temperatures, fresh water availability or habitats change. However, new species may start to appear/become more established in the region. The ability to migrate may be constrained by habitat fragmentation. It may be necessary to provide land for additional/alternative habitats for example intertidal habitats subject to coastal squeeze.
- 3.8 Climate change may also impact on **landscapes and heritage** in the region. Sea level rise, in combination with more frequent rainfall in winter, could lead to increased erosion (e.g. of the Heritage Coast) and temperature changes may influence the way land is managed in the region. Increasing flooding could also put a range of different heritage sites at risk of damage. Map 8 indicates a wide spread across the region of such sites in flood risk areas.



**Map 8** : Heritage sites in Flood Zone 2

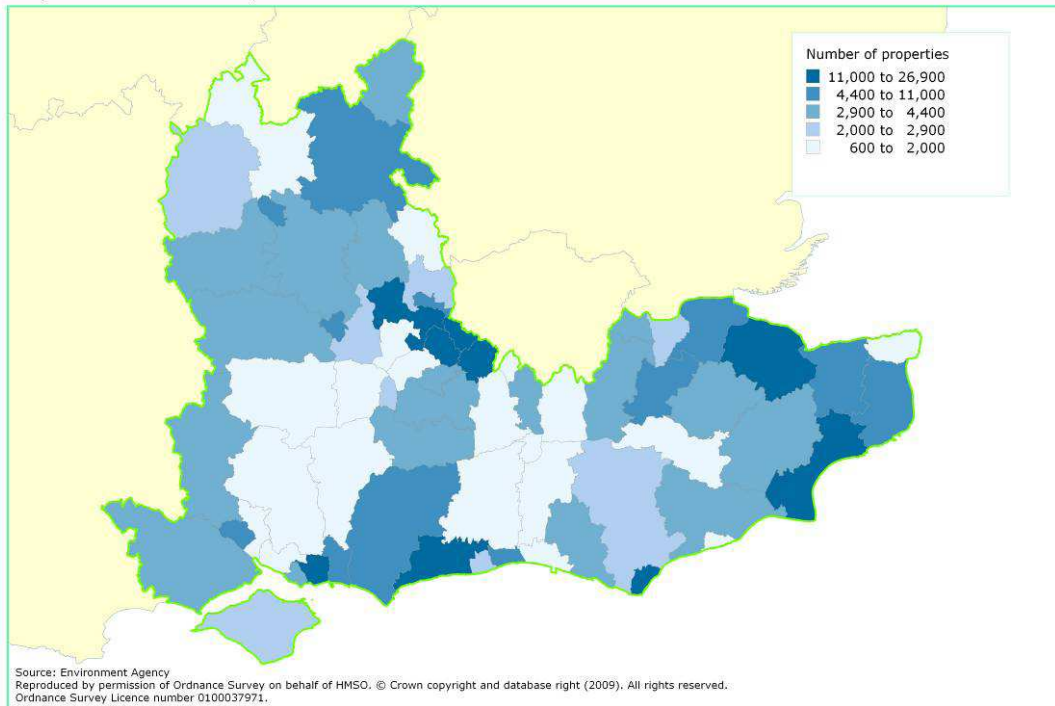
## Built Environment

- 3.9 Climatic change is likely to lead to more severe and frequent flooding.<sup>11</sup> Different parts of the region have recently experienced numerous flooding events (e.g. along the river Thames in 2007). The risk of surface water flooding in urban areas may increase in particular in the light of more torrential and frequent rainfall events especially during winter and the risk of tidal flooding is likely to be affected by sea level rise. Whilst the Regional Flood Risk Appraisal by the former Regional Assembly focused on future growth and identified South Hampshire, the Kent Thames Gateway, Ashford, Milton Keynes, Aylesbury, Oxford, Didcot, Reading, Crawley and Shoreham as areas where high flood risk and high growth coincide. This study addresses also the existing built environment.
- 3.10 Portsmouth, Eastbourne and urban areas in the North West of Surrey as well as the rural coastal authorities Swale, Arun and Shepway have high numbers of **properties** in high flood risk areas (see Map 9). With the exception of the Surrey authorities and Shepway all of these authorities have comparatively low average earnings (see Map 10). Portsmouth, Eastbourne and Swale have also a high proportion of deprived areas (see Map 1). However, the low income and deprived areas are not necessarily where the flood risk is high in these authorities. It also depends if households are expected to fund adaptation measures. Map 11 highlights that in some areas of Buckinghamshire and the north of Surrey the share of properties at high risk of flooding signed up to a flood warning scheme

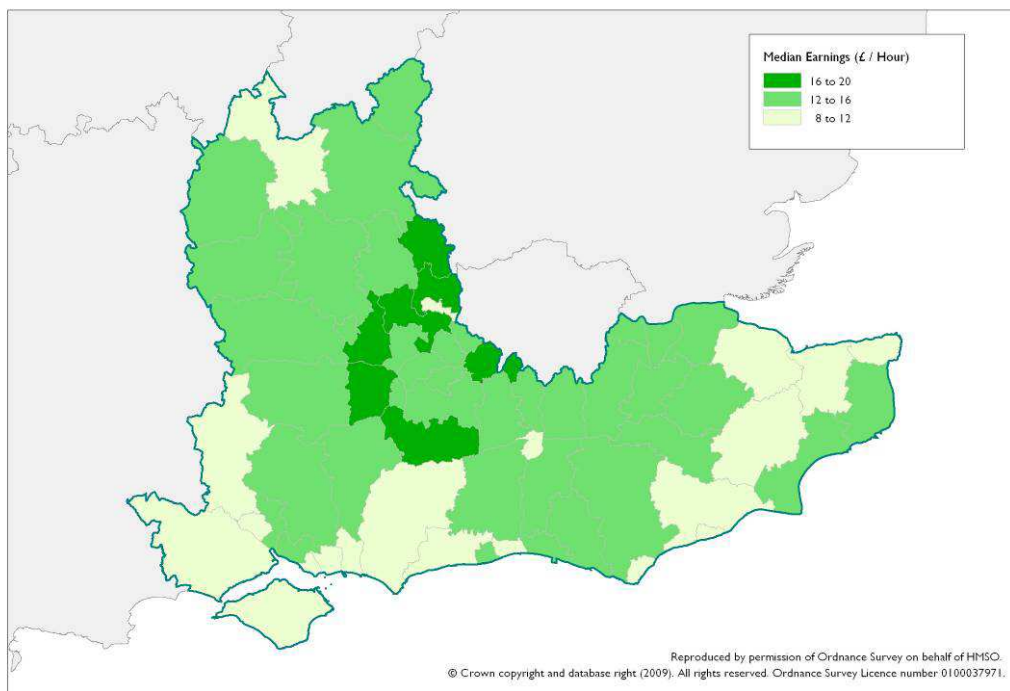
<sup>11</sup> Overheating of urban areas is addressed in the population section (para 3.2).

is very low, however this does not take into account the scale of flood risk in these areas.

Properties in Flood Zone 3, 2008

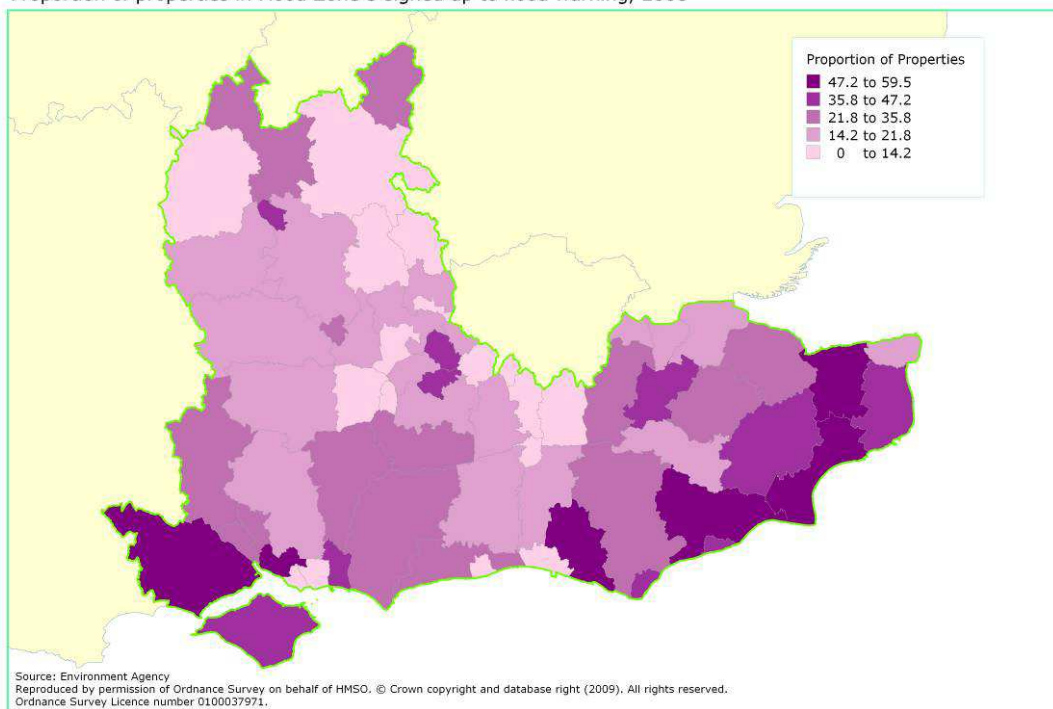


**Map 9 :** Number of properties at high risk of flooding – the risk for these properties is likely increase further through climate change



**Map 10:** Average earnings – people with low income may find it more difficult to make their property resilient against severe weather

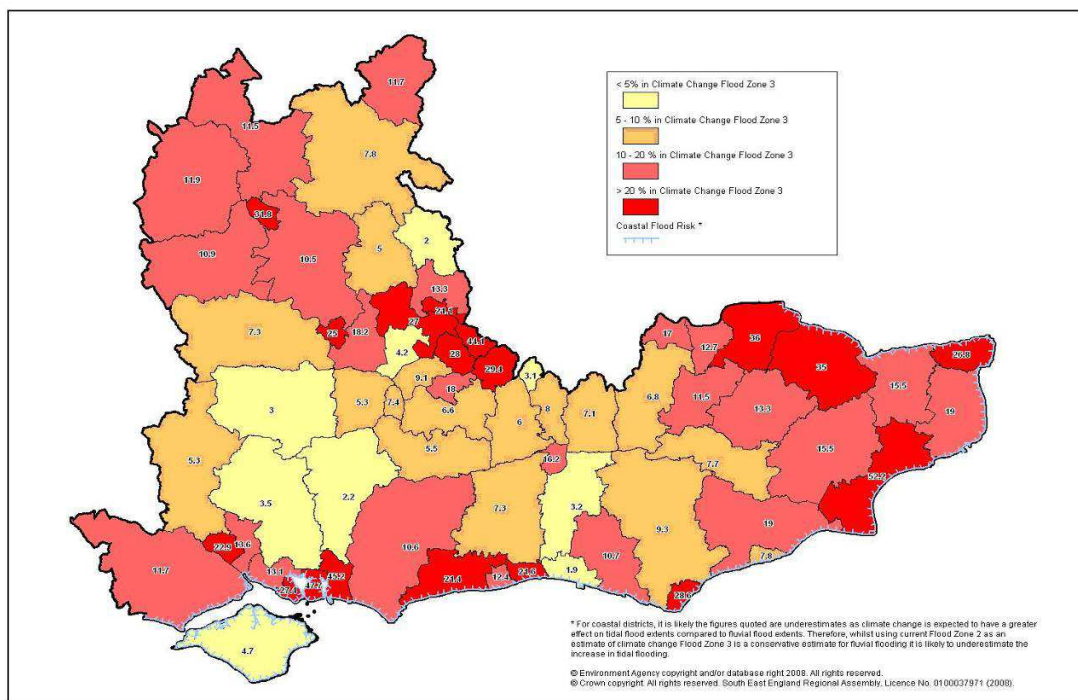
Proportion of properties in Flood Zone 3 signed up to flood warning, 2008



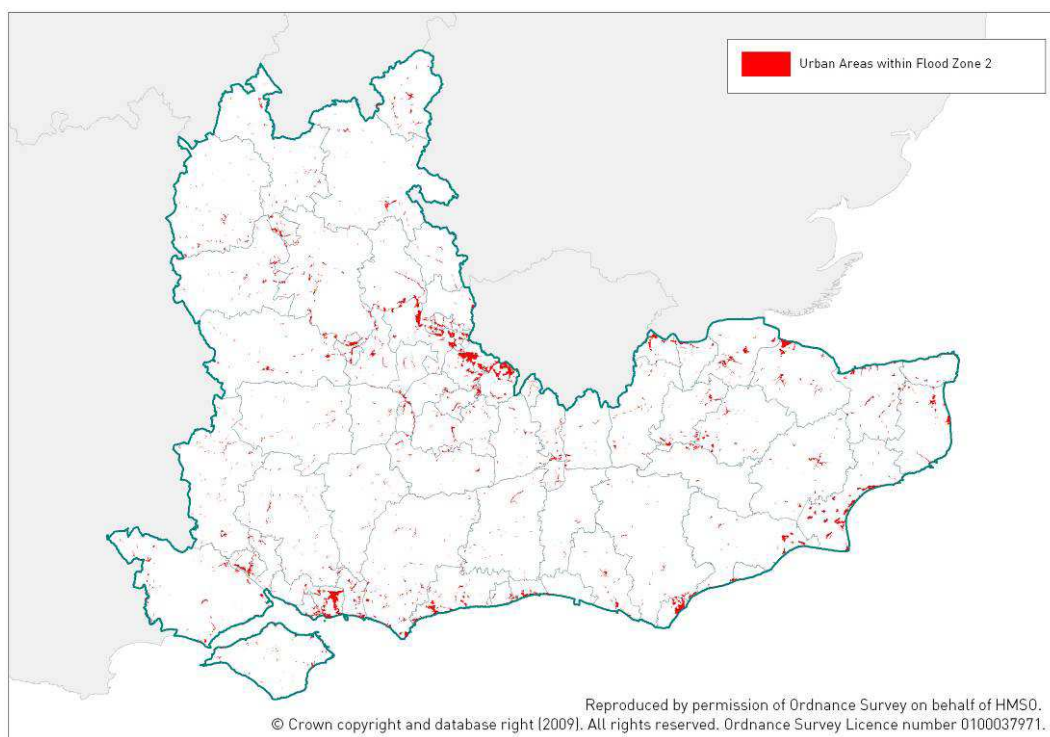
**Map 11** : Properties signed up to flood warning – this can reduce potential damage from a flooding event

3.11 Increases in the frequency and intensity of (winter) precipitation and sea level rise could cause more damage to properties already at risk and additional properties in the future. This could have an impact on housing supply and demand. There may also be an increasing number of properties, which cannot be insured any more due to the scale of flood risk. Map 12 highlights areas with a high proportion of high flood risk in about 100 years (current Flood Zone 2).<sup>12</sup> In Shepway, Havant, Portsmouth and Spelthorne over/almost half the land will be at high risk of flooding, whilst the increase in flood risk on the coast is likely to be even more significant than assumed. However, focusing again on the built environment Map 13 indicates that Portsmouth, Spelthorne, Elmbridge and Eastbourne have a significant proportion of urban land within Flood Zone 2. However, these are not necessarily the areas with the most vulnerable uses.

<sup>12</sup> It can be assumed that over the next 100 years flood risk in the areas with a current 0.1% chance of flood risk (Flood Zone 2) will increase to a 1% (for rivers) /0.5% (for sea flooding) chance (Flood Zone 3).



**Map 12:** Proportion of district in Flood Zone 213



**Map 13: Urban areas in Flood Zone 2**

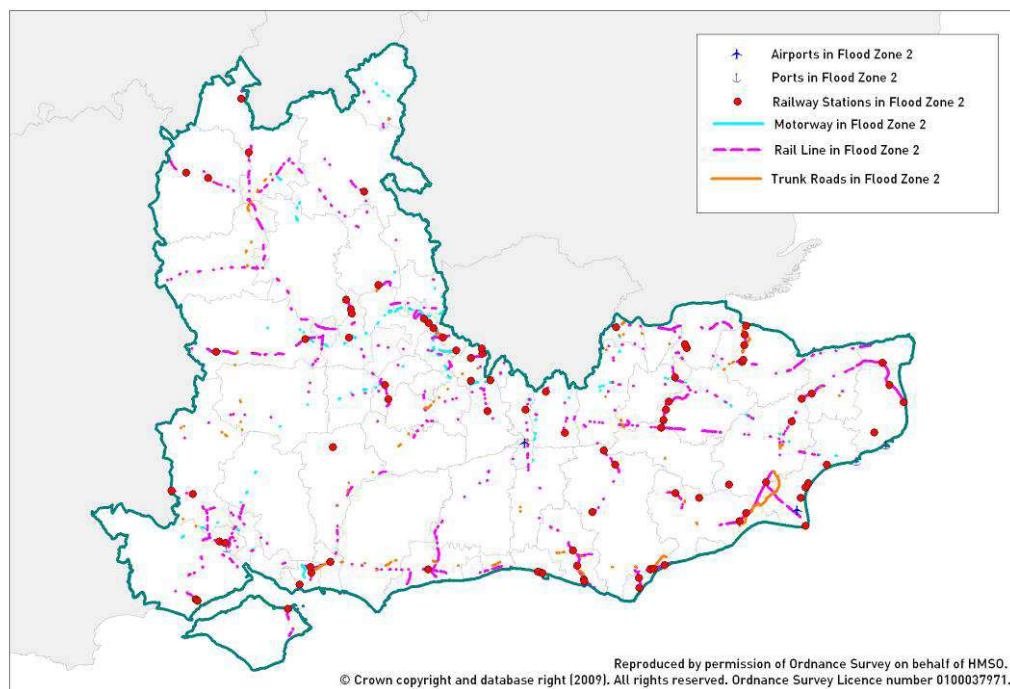
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It can be assumed that over the next 100 years flood risk in the areas with a current 0.1% chance of flood risk (Flood Zone 2) will increase to a 1% (for rivers) /0.5% (for sea flooding) chance (Flood Zone 3).

- 3.12 Investment in adapting the existing built environment is required to reduce vulnerability. In the long-term the relocation of individual properties/settlements may have to be considered to address flood risk sustainably. This would require significant investment.

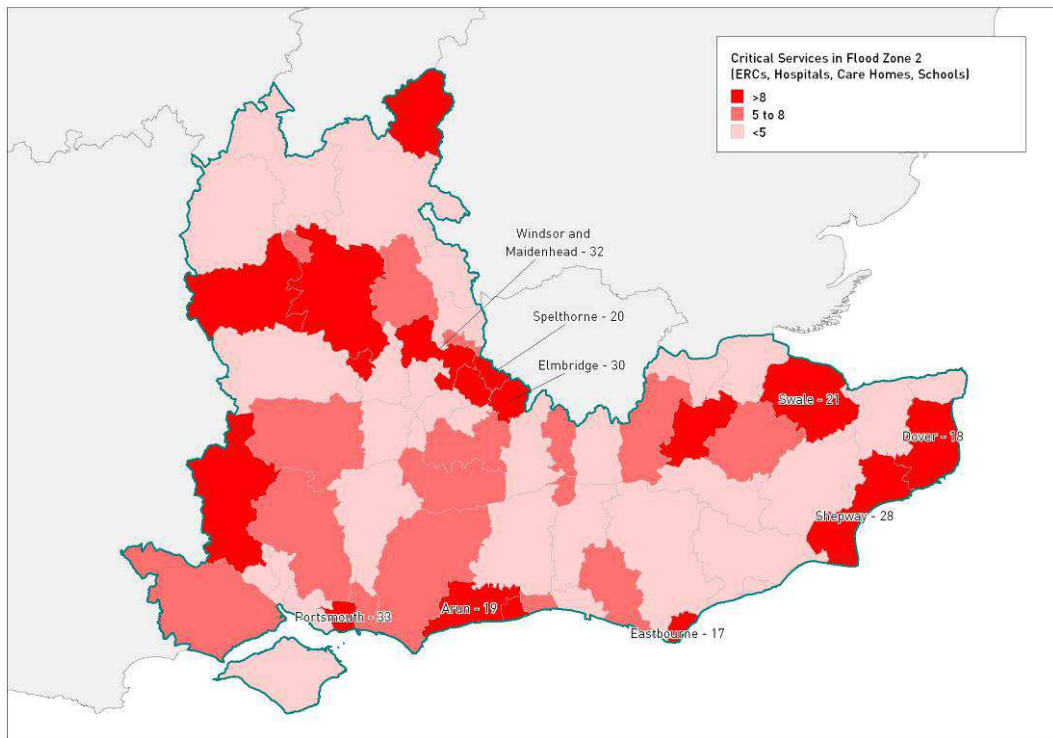
## Infrastructure

- 3.13 Parts of the **transport** network and several key interchanges lie within Flood Zone 2 (see Map 14). More frequent instances of severe weather (in particular winter rain and summer heat) and sea level rise are likely to result in increased damage to road and rail infrastructure within such areas and may affect the reliability of the networks and services. Such locations/routes already currently affected may be at further increased risk, and may require protective measures or even relocation in the longer-term.



**Map 14:** Strategic transport infrastructure and key interchanges in Flood Zone 2

- 3.14 For **critical services** such as hospitals, schools and care homes Map 15 shows that in particular in Portsmouth, Windsor and Maidenhead, Elmbridge and Shepway many are in Flood Zone 2. Such services require particular protection, with hospital requiring the highest level of protection.

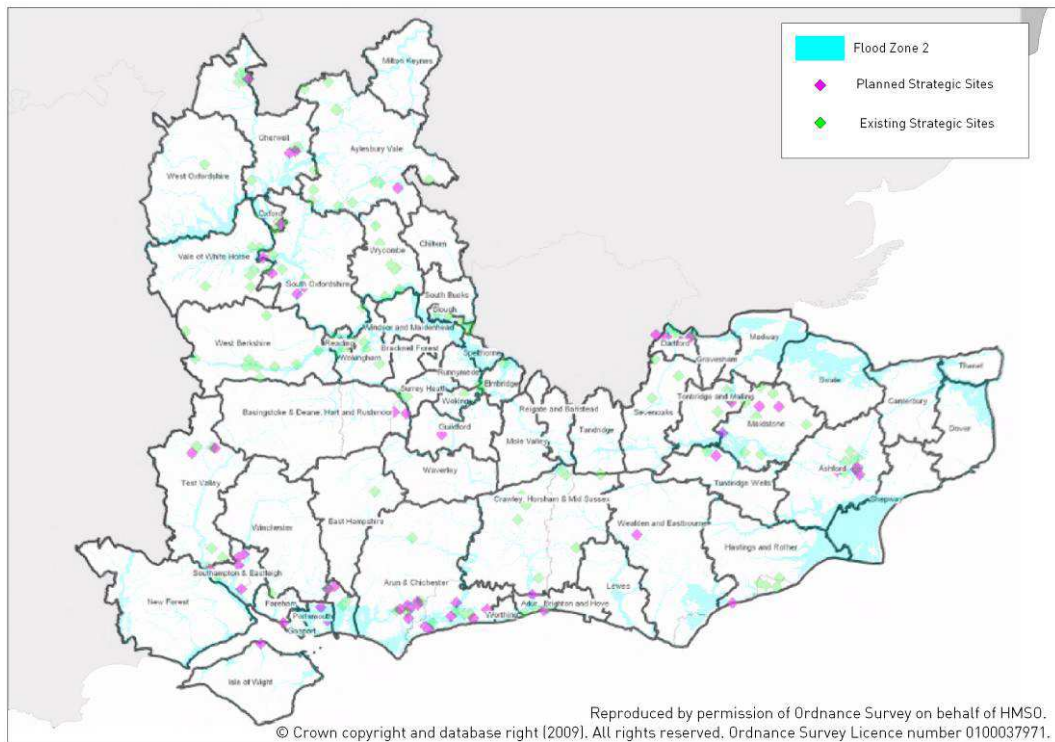


**Map 15:** Critical services in Flood Zone 2

- 3.15 Overall, there is a need to promote the links between emergency planning and other services to enable a coordinated response to more frequent severe weather.

### **Economic development**

- 3.16 Many strategic **employment sites** are at risk of overheating and flooding. Map 16 indicates the latter is the case across the region.



**Map 16:** Strategic employment sites and Flood Zone 2<sup>13</sup>

- 3.17 With climatic change the risk of damage to business assets and infrastructure/services required by businesses as well as reduced productivity through extreme heat and flooding is likely to increase without investment in adaptation measures or even relocation. **Business sectors** that depend on specific weather conditions or high water consumption will be particularly sensitive to climatic changes. Such sectors include for example agriculture and tourism. Implications on the latter through warmer/drier summers could be positive. Changes to the global climate could also trigger significant migration with considerable economic implications.
- 3.18 The availability of data and information about specific impacts of climate change on the economy in different parts of the region is poor, and further research should be undertaken.

## 4. Conclusion

- 4.1 Flooding is the most significant issue related to climate change vulnerability in the region. The risk of surface water flooding in urban areas may increase in particular in the light of more torrential and frequent rainfall events especially during winter and the risk of tidal flooding is likely to be affected by sea level rise. Whilst the Regional Flood Risk Appraisal focused on future growth, this study also addresses the existing built environment. Areas that are likely to be particularly vulnerable include Portsmouth and Eastbourne as well as the rural coastal authority of Swale. In all three authorities deprivation and low average earnings may make the implementation of adaptation measures difficult if

<sup>13</sup> Poor quality of the map as employment sites are not available in GIS format

households are expected to fund them or residents are less able to relocate.

- 4.2 Urban areas in the North West of Surrey such as Spelthorne and Elmbridge are also comparatively vulnerable to increasing flood risk but could in addition experience urban heat more extremely than other parts of the region. However, as these areas are comparatively affluent, there may be more capacity/opportunities for residents to realise adaptation measures.
- 4.3 Other mapping results are currently considered difficult to aggregate as a spatial pattern has still to emerge and further research is required.
- 4.4 It has to be highlighted that the basis for the above identification of areas potentially particularly vulnerable to climate change impacts is very fragile and requires further development. Their level of detail does not allow to draw conclusion without further investigations at local level as infrastructure/services at risk might be located in border areas affecting neighbouring districts. A range of Local Climate Impact Profiles (LCLIPs) are already underway to explore local risks in more detail. For some other potential issues/indicators the correlation with climate vulnerability is based on assumptions, for others we require specific data from sector organisations. Consequently we have only been able to map very few datasets so far. A high proportion of them is based on Flood Zone data, which do for example not reflect the important aspect of surface water flooding. For other factors we are also still trying to identify suitable data. They include for example the risk of erosion and the vulnerability of important habitats. The consequences and costs of recent severe weather events in different areas of the region and the capacity of services to cope are a few examples of information that would be valuable to complement the current set of maps. Annex 2 provides an overview of potential additional issues/indicators under consideration.
- 4.5 The global impacts of climate change could have further profound effects on the region, for example crop failures and consequent food insecurity, resource scarcity, and flooding of low-lying regions potentially leading to mass migration. However, as these consequences are extremely unpredictable, they have not been considered.

## **5 Next Steps**

- 5.1 We aim to revise this draft report on the basis of comments from the Steering Group and to complete a draft in January 2010 for wider engagement of climate experts in different sectors and at local authorities.
- 5.2 This will inform another iteration of the vulnerability assessment, which we plan to complete with support from consultants during spring 2010. During this phase we will also look specifically at
  - The exploration of additional data where gaps have been identified, for example in the economic development sector
  - The use and comparison of Local Authorities' Local Climate Impact Profile (LCLIP) findings as far as available
  - The use of data from regional stakeholders that manage assets and provide services/infrastructure to assess climate change vulnerability

- The use of climate projection data to indicate the potential scale of change to climate vulnerabilities and consequences
  - The prioritisation of the best issues/indicators based on the strategic significance of their performance, the potential relevance for the Regional Strategy, the confidence in the data and the underlying assumptions
  - The possibility of identifying vulnerability 'hotspots'
  - The user-friendly presentation of the results of the work so far and their dissemination
- 5.3 These results should inform the spatial options development of the Regional Strategy later in 2010, the prioritisation/location of adaptation measures and the national Climate Change Risk Assessment.

**Jörn Peters**  
**Regional Planner**

4 February 2010