“Adaptation by societies and economies alone is not considered to be sufficient to address the complexity, range and magnitude of risks and opportunities associated with climate change (EEA, 2014).”

Introduction

Flooding is the costliest natural disaster worldwide, and the effective management of long-term flood risk is an increasingly critical issue for many governments across the world, especially in light of climate change. In England flooding is recognised as one of the most common and costliest natural disasters and is listed as a major risk on the National Risk Register. The consequences of surface water flooding were brought to the forefront by the summer floods of 2007, which caused the country’s largest peacetime emergency since World War II. The total economic cost of the floods was estimated to be £3.2 billion (2007 prices), with £2.5 billion borne by households at a cost of £1.8 billion to insurers (Environment Agency, 2010).

The Pitt Review (Pitt, 2008), conducted to provide lessons and recommendations in the aftermath of the 2007 summer floods, highlighted major gaps in the understanding and management of risks from surface water flooding. Similar concerns have also been raised across Europe with some member states in the past giving a much lower priority to this type of flood risk meaning that vulnerability has crept upwards (European Water Association, 2009). The Pitt Review emphasised the need for urgent and fundamental changes in the way the UK is adapting to the likelihood of more frequent and intense periods of heavy rainfall projected under future climate change (IPCC 2013). Changing precipitation patterns are expected to result in an increase in surface water flood events in the UK (Ramsbottom et al., 2012). Combined with an increasing pattern of urbanisation it has been estimated that damages from surface water flooding could increase by 60-220% over the next 50 years (Adaptation Sub-Committee, 2012).

The combination of biophysical and human factors influencing surface water flood risk means that it is extremely challenging to predict the occurrence and extent of events, limiting the ability to warn and plan for future risks (Houston et al., 2011). This and the large number of stakeholders involved (e.g. in the case of the UK and London see Jenkins et al., (2016)) make managing surface water flooding a very complex issue that requires multi-sectoral collaboration. One area where this is particularly apparent is flood insurance.

A unique aspect of cross-sectoral involvement in flood management in the UK is the public-private partnership on flood insurance between the government and insurance industry known as the **Statement of Principles (SoP)**. Flood insurance in England (and across the United Kingdom) is unique amongst most other national schemes as it is purely underwritten by the private market, while the government commits to flood risk management activities. The SoP was established in 2000 in the wake of growing flood losses and sets commitments from both the insurance industry and government to establish flood insurance provision. The main obligations can be summarised as follows: flood insurance is provided by private insurers under the SoP to both households and small businesses, generally up to a risk level of 1:75 return period (RP) (1.3%) as part of their building and/or contents cover. Properties at higher risk are granted cover if insurers are informed by the Environment Agency (EA) about plans for flood defence improvements for the particular area within the next five years. Government commits to investment in flood defences and improved flood risk data provision as well as a strengthened planning system. Under this agreement, the emphasis on flood risk reduction is primarily placed on the government (national and local) as insurers provide the financial underwriting. While insurers traditionally insure against all types of flooding in the UK, over the last decade the concerns about surface water flooding have contributed to a review of existing insurance practices.

In 2008, the SoP was extended for a final five-year period until 2013 and committed the government and insurance industry to a transition to a free market for flood insurance. However, sparked by concern about rising risk costs, the frequency of high loss events and the belief by the insurance industry that a free market might leave around 200,000 high risk homes struggling to afford cover (Committee on Climate Change, 2015) a modified version of the partnership was agreed in 2013 with the creation of Flood Re, which started operations in 2016. Designed to secure affordable cover for properties at high risk of flooding, Flood Re complements the current insurance market, where private insurers are offering cover against flood damage as part of standard home insurance policies. Households under low to normal flood risk will still be provided with insurance as standard, whilst the flood element of the home insurance policy for the 1-2% of highest risk properties can be passed to Flood Re by insurers (Figure 16.1). The premiums offered for high risk households are fixed dependent on council tax banding. Flood Re will be funded by these premiums and an annual levy taken from all policyholders and imposed on insurers according to their market share (Surminski & Eldridge, 2015). The proposed Flood Re scheme is designed by Government and industry as a transitional solution, with an anticipated run time of 20-25 years. It aims to help smooth the transition to more risk-based pricing in a competitive insurance market in the future, while securing future affordability and availability of flood insurance (Defra, 2013).

Photo by Portokalis/Shutterstock.

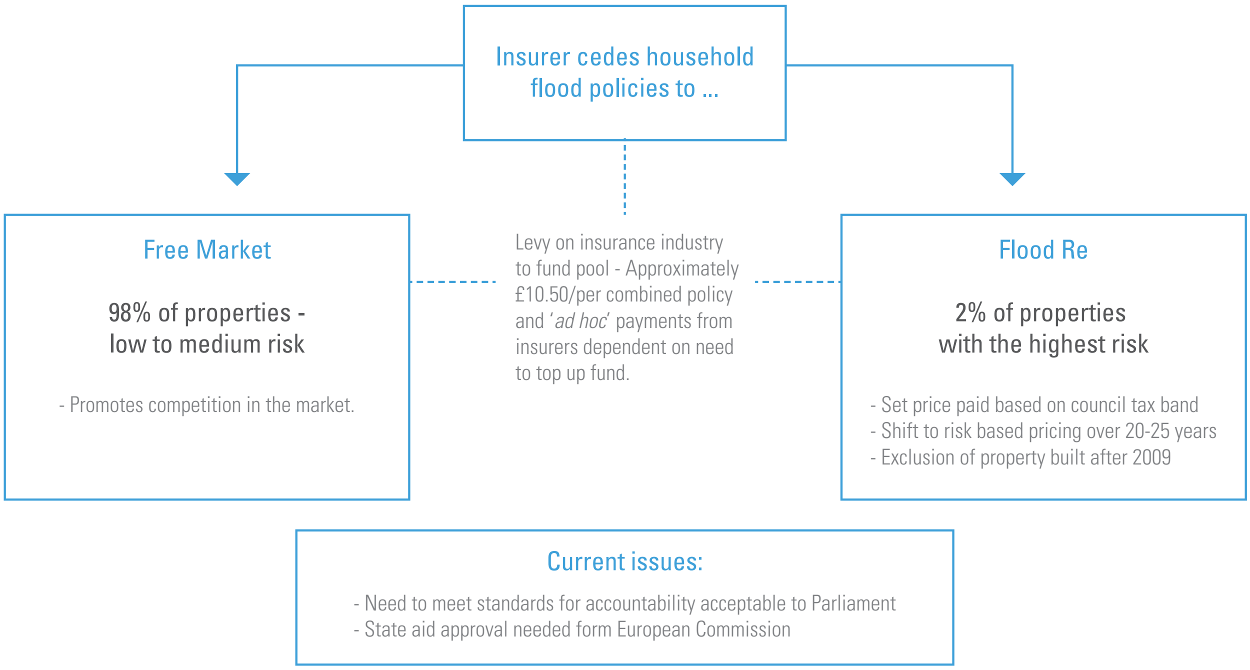


Figure 16.1.

The proposed Flood Re system. Details taken from the Environment, Flood and Rural Affairs Committee on 26th February 2013 for the Flood Re insurance proposal and Flood Re MoU (Source: Defra and ABI, 2013).

While the change in the flood insurance scheme has been triggered by concerns of insurers about rising flood losses and concerns of at risk homeowners over future affordability, it remains unclear if and how Flood Re will be able to cope with future risks and fulfil its tasks (Surminski & Eldridge, 2015). Rising losses and increased volatility can affect the fine balance between affordability and profitability for insurers. In extreme cases this could lead to insurers withdrawing from certain markets and regions, as highlighted by the UK's insurance regulator PRA (Prudential Regulation Authority, 2015). While the recent flood loss trends in the UK are largely due to socio-economic factors, such as more development in exposed areas, climate change is expected to exacerbate these impacts (IPCC, 2013). One important aspect therefore is **if and how the insurance partnership can be integrated into overall risk management and climate change adaptation efforts, and how insurers can collaborate with other stakeholders to achieve greater resilience and ensure future insurability**.

In this analysis we investigate this through a local lens: we focus on a case study of Greater London for evaluating existing and potential new partnerships for surface water flood risk management. Floods are a major issue for London, as it is vulnerable to tidal, fluvial, surface water, sewer and groundwater flooding. Surface water flooding is considered to be the most likely cause of flood events in London, and one of the greatest short-term climate risks (Greater London Authority, 2009, 2011). Around 680,000 properties are estimated to be at risk with 140,000 Londoners at high risk, and another 230,000 at medium risk (Greater London Authority, 2014).

We investigated the existing public-private flood insurance partnership and the proposed new insurance scheme Flood Re, and explored how this could influence London's resilience to surface water flood risks today and in the future. The case study combined qualitative analysis in the form of relationships, governance and risk levels, and the development and application of a quantitative oriented agent-based model (ABM) to capture and model the dynamics of surface water flooding, changing surface water flood risk, and how adaptation and insurance decisions could affect future surface water flood risk in that dynamic.

York, UK - December 27, 2015: Flood water near Clifford's Tower, York. Photo by Phil MacD Photography/istock.

Investigating the aims of Flood Re - the 'design principle' approach

An investigation of the underlying design principles of insurance considers the aims and objectives stated by different stakeholders during the development and design of an insurance scheme, and asks if and how those have been met by the eventual solution that was implemented.

Different stakeholders have different constellations and problem definitions. There are a range of political motivations at play when considering introduction or reform of flood insurance schemes, showing that the pendulum of political support can swing in many directions. On the one hand there is the aim of reducing current public expenditure for flood losses, while at the same time there are political considerations such as the need to maintain a visible 'helping hand' function after a disaster.

The investigation of design principles allows insights into potential trade-offs between certain aims, such as affordability, availability, and vulnerability reduction, particularly when considering the political realities that drive the reform or development of new insurance schemes.

At the start of the negotiations for the new flood insurance mechanism a set of principles were published by the UK government outlining the vision for flood insurance (Figure 16.2). This had a clear emphasis towards affordability and availability of insurance provision. Yet adhering to all these principles has proved extremely difficult.

The proposed scheme, Flood Re, takes principles 1, 3 and 8 at its core and aims to 'ensure the availability and affordability of flood insurance, without placing unsustainable costs on wider policyholders and the taxpayer' (Defra 2013a). However, the 'value for money' aspect of this is highly debatable as the scheme does not meet the minimum government standard for cost-benefits (Defra 2013a p.30; Defra 2013b). The lack of risk reduction was clear in the official proposal other than in the Memorandum of Understanding, setting out the government's commitment to flood risk management and joint efforts to improve flood risk data (Surminski & Eldridge, 2015).

Furthermore, the qualitative analysis also highlighted a lack of reflection on climate change. The findings from the qualitative analysis challenged the government's assumption that flood risk management will keep up with climate change and that therefore risk levels would remain stable, and was incorporated in subsequent policy impact assessments.

Photo by ronfromyork/Shutterstock.

Figure 16.2.
Principles for flood insurance (Source: Defra, 2011a, p.5).

Principles

1. Insurance cover for flooding should be widely available.
2. Flood insurance premiums and excesses should reflect the risk of flood damage to the property insured, taking into account any resistance or resilience measures.
3. The provision of flood insurance should be equitable.
4. The model should not distort competition between insurance films.
5. Any new model should be practical and deliverable.
6. Any new model should encourage the take up of flood insurance, especially by low-income households.
7. Where economically viable, afforadable and technically possible, investment in flood risk management activity, including resilience and other measures to reduce flood risk, should be encouraged. This includes, but is not limited to, direct Government investment.
8. Any new model should be sustainable in the long run, affordable to the public purse and offer value for money to the taxpayer.

Assessing surface water flood risk and management strategies under future climate change - an agent-based model approach

Analysing the outcomes of such an insurance reform as Flood Re, and its potential integration with flood risk management and climate change, required a model that could simulate the dynamics of flooding, changing levels of risk, and the choices made by different stakeholders. ABMs provide a bottom-up approach for understanding the dynamic interactions between different agents in complex systems. They are particularly advantageous for visualising the effects of changing behaviours and emergent properties of complex adaptive systems. They have a number of advantages as a support tool for policy-making such as their accessibility and flexibility for testing different conditions and behavioural rules (van Dam et al., 2012).

An ABM was developed for Greater London and applied to a case study of the London Borough of Camden, an area at high risk of surface water flooding (although the modelling approach could also be extended to other areas in the UK or specific situations in other countries). The ABM includes six different agents: people, houses, an insurer, a bank, a developer and a local government, each with their own behaviour (see Dubbelboer et al. (2016) and Jenkins et al. (2016) for further model details). The model was used to assess the interplay between different adaptation options; how risk reduction could be achieved or incentivised by different agents; and the role of flood insurance and Flood Re, all in the context of climate change.

The ABM highlighted how socio-economic development could exacerbate current levels of surface water flood risk in Camden. Surface water flood risk increased over time, reflecting the continued development of properties in areas of flood risk in the model, and under the high emission climate change scenarios for the 2030s and 2050s modelled. An analysis of the role of Flood Re and structural adaptation options, in the form of Property-level Protection Measures (PLPMs) and Sustainable Drainage Systems (SUDS), for managing surface water flood risk highlighted that the most beneficial result for risk reduction was a combination of investment in both PLPMs and SUDS (Figure 16.3). However, even with SUDS and PLPMs in place the average surface water flood risk continued to increase over time under all experiments. Given the implications of climate change on surface water flood risk this illustrates the danger of further trade-offs between future development plans and flood risk management.

For insurance the model showed that Flood Re would achieve its aim of securing affordable flood insurance premiums (Figure 16.4). However, findings also highlighted that the new pool would be placed under increased strain if challenged with increasing risk as highlighted by the future climate change projections. The results also showed that the implementation of Flood Re had no additional benefits in terms of overall risk reduction. This supports the concerns that the scheme is missing an opportunity to contribute to risk reduction.

Figure 16.3.

The average surface water flood risk calculated for each of the experiments under the baseline, 2030 high and 2050 high climate scenarios.

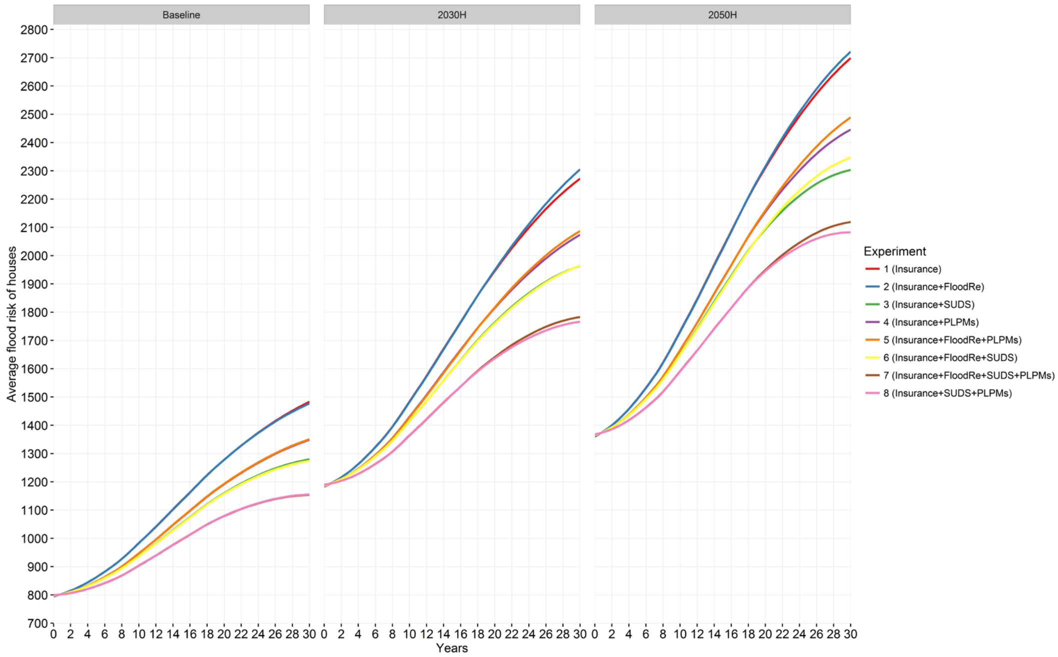
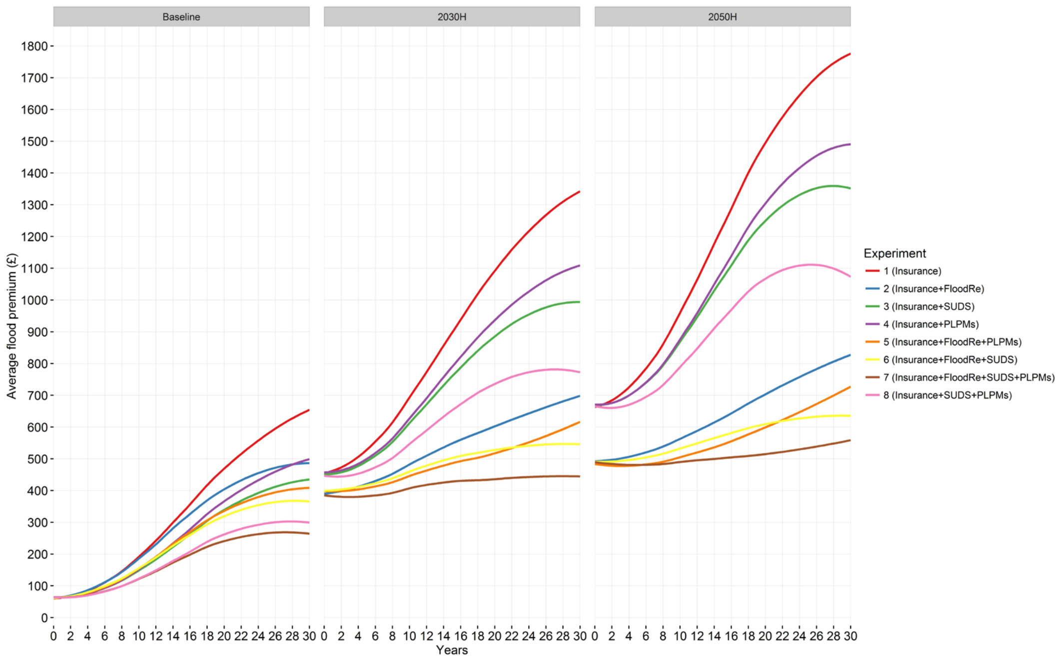


Figure 16.4.

Average flood premiums of houses in risk for each of the experiments under different climate scenarios.



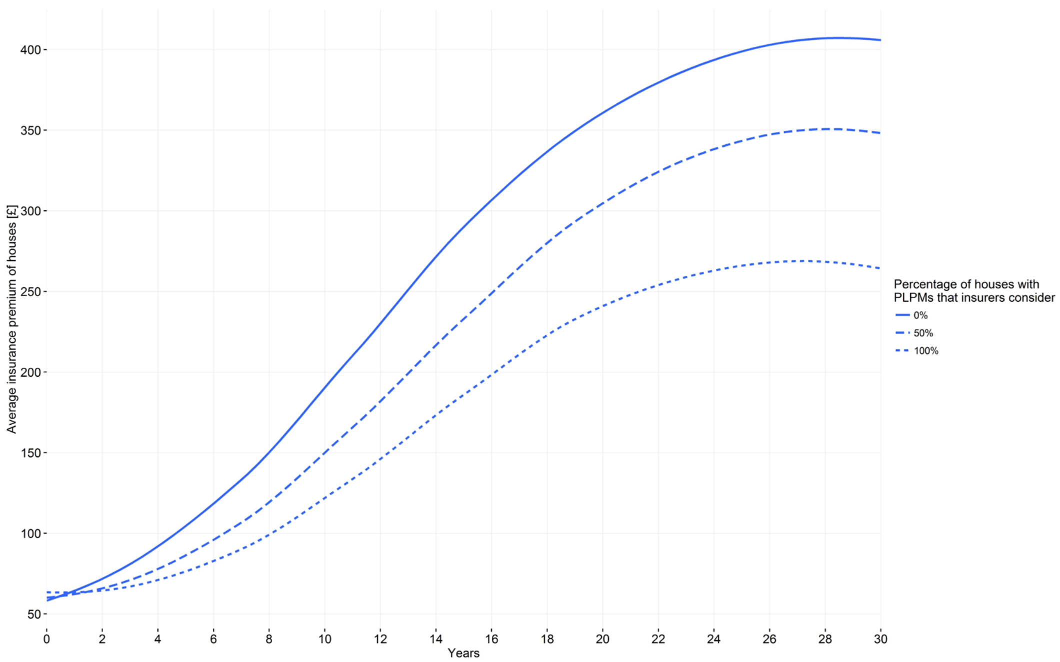
The analysis also focused on the role of different actors in the MSP. Despite calls for greater private sector involvement in flood and disaster risk management there is still a lack of clarity around the roles these different actors can play and, in particular, around the interactions and trade-offs in their actions. The ABM allowed us to test the current partnership by examining the role that the local government and insurers can play in reducing surface water flood risk and/or incentivising risk reduction behaviour by households. For example, by investigating the effect if the insurer accounted for investment in PLPMs when calculating the flood risk of houses and setting premiums. This highlights one incentive that could be given to homeowners to invest in PLPMs either proactively or in response to a flood event. Figure 16.5 shows that for the baseline climate scenario average household flood premiums are reduced by 38% to £250 by year 30 when insurers consider PLPMs, compared to £400 when they are not accounted for.

In addition, by including other agents in the partnership the ABM allowed us to see if and how their actions could reduce flood risk. As future development could exacerbate current levels of surface water flood risk the role of the developer and hypothetical changes to regulations which would impact upon their decision-making and development of new homes was analysed. The level of surface water flood risk was highest in the model when no developer restrictions were in place, and lowest when the developer was required to build all new properties with SUDS. The reduced flood risk subsequently resulted in reduced average household flood insurance premiums when accounted for by the insurer.

The effect of increased/decreased government investment in PLPMs and SUDS, and hypothetical changes to development regulations, were also investigated. Benefits of government investment in flood protection measures were larger when directed towards new build hous-

Figure 16.5.

The average SW flood insurance premium of houses when the insurer agent does/doesn't account for installed PLPMs.



es, which include properties in some of the higher flood risk areas in the model, and which are targeted for SUDS projects based on the favourable cost-benefit ratio. As above increased investment in flood protection measures had a positive effect on flood insurance premiums (although this remains much higher for new build houses as they are excluded from Flood Re).

However, as important in the partnership is the role of the local government in approving local developments. A 50% reduction in surface water flood risk of the area was seen when it was assumed that for every planning proposal the government lowers their level of maximum flood risk they would accept, or if this is exceeded requires the sale of the land for development to result in a higher level of profitability. Consequently, more stringent government criteria for approving new developments resulted in fewer new properties being built in areas of high flood risk. Figure 16.6 highlights the simulated increase in new build properties in east Camden compared to west Camden when more stringent regulations are placed on developers.

Overall, the most beneficial results in terms of flood risk reduction were seen when the full range of developer and government conditions were implemented together in the model. The analysis also highlighted the importance of coordinating the developer and local government risk reduction strategies. For example, if the developer builds all new properties with SUDS the resultant reduction in flood risk means that many are approved, even when the local government reduces the acceptable level of flood risk. However, while SUDS help reduce risk they may not mitigate it fully. The potential for counteractive effects when combining constraints and measures targeted to developers and the local government is a key finding of this research and an area which warrants further investigation.

Furthermore, the magnitude and trends in average flood premiums seen when different insurer, government, and developer conditions were implemented also differed largely when future climate change was considered. This suggests that there is no single long-term optimal approach to managing surface water flood risk and maintaining affordable premiums, with the benefits and trade-offs of options changing over time with climate change, changing levels of flood risk, and changes to the built environment.

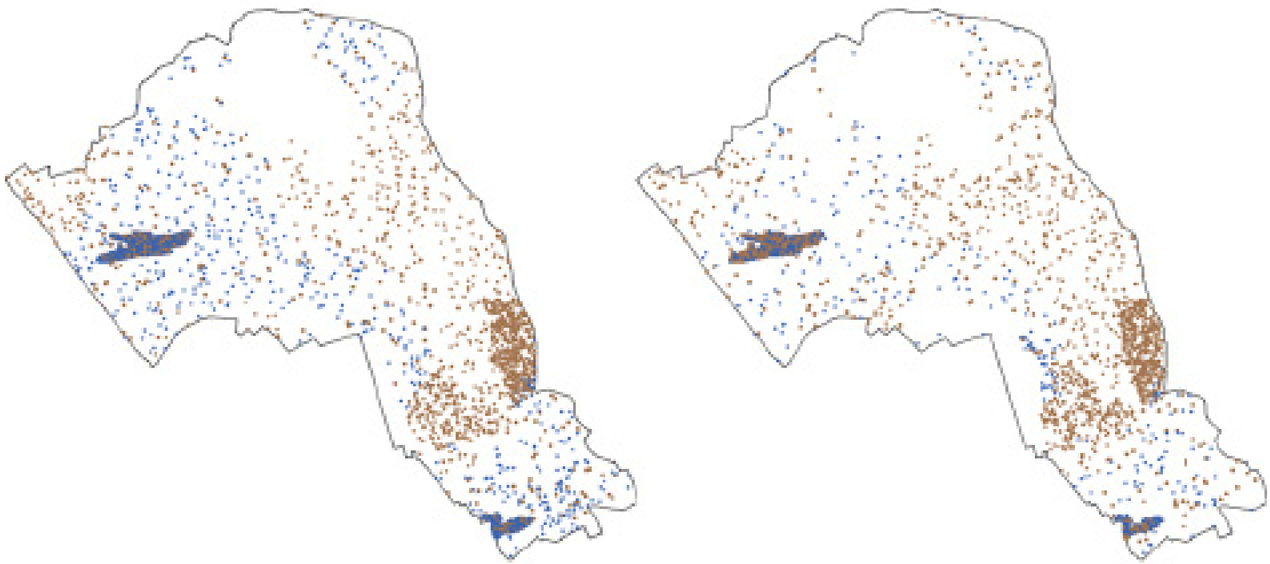


Figure 16.6.

The spatial location of new build properties in the London Borough of Camden built in flood risk (blue) and not built in flood risk (brown). The left panel shows results under the initial model setup, and the right panel results when there are stricter government criteria for approving development proposals (baseline climate scenario).