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What can cities do to increase resilience?

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This paper examines climate change mitigation and adaptation from an insurance industry perspective, with particular reference to London and the USA. It illustrates how British insurers are increasingly shaping public policy and using new technology to manage the risks from climate change impacts and makes a plea for society to make more use of insurance expertise in future decision making. In particular, more dialogue is needed between architects, planners and insurers to adapt our buildings and cities for climate change impacts. The paper is an abbreviated and updated version of the paper presented by the author in Houston, Texas, in 2005.

Keywords: insurance; risk; flood; storms; architects; planners

1. Explanatory note: Great Britain

Great Britain is a collection of over 400 islands off the coast of the continent of Europe. According to the CIA website, it is about the size of the State of Oregon in the USA. Despite its size, it is the fourth largest economy in the world. Some of the examples in this paper relate to insurance activities in Great Britain (GB), and it may be useful to explain that Britain is made up of the two kingdoms of England and Scotland together with the Principality of Wales. Therefore, it is wrong therefore to say ‘England’ when referring to Britain as a whole. Indeed, Scotland accounts for 40% of the land area of Britain and 9% of the population. One county in Scotland is bigger than Belgium, while another has a longer coastline than France.

Scotland has its own established church, and separate legal and educational systems. It also has its own banknotes and language (Gaelic) although this is spoken only by a minority. The Shetland Islands, while within Scotland politically, have a separate legal system and language, and a measure of local autonomy. Since devolution in April 1999, Scotland has had its own elected parliament, which has legislative powers over internal affairs.

Wales has its own language, church and elected assembly, but this has no legislative powers so in terms of legal and political organization that is similar to England. For some of the issues considered below, it is necessary to distinguish between England and Wales on the one hand and Scotland on the other, because

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the approaches are significantly and increasingly different, especially with regard to local authority matters such as land use planning and building standards.

The United Kingdom consists of GB plus the Province of Northern Ireland. The 'British Isles' is a geographical term rather than political, and consists of the UK, plus the Republic of Ireland, and the UK Crown Dependencies of the Isle of Man and the Channel Islands.

2. Introduction

An international report ([The International Climate Change Taskforce 2005](#)) published in January 2005 warned that the then level of 379 ppm of carbon dioxide (CO₂) in the atmosphere was rising by more than 2 ppm per year and could reach 400 ppm within 10 years. This would be enough to generate a 2°C rise in global temperature from pre-industrial levels. Many experts now say that this is the point of no return when feedback effects will lead to runaway climate change and the prospect of significant rises in sea level in the lifetime of our grandchildren. The latest measurements, published in March 2006, show that within just over a year, the levels of CO₂ had risen to 381 ppm and if the CO₂, nitrous oxide and methane releases are taken into account the total CO₂ equivalent is already over 425 ppm.

According to an opinion poll in 2005, before Katrina and the G8 summit, 45% of the British public believed that climate change is the most serious challenge faced by the world. However, 26% want economic growth instead and governments stand accused of being 'too afraid of short-term electoral punishment to do what is right' ([Independent 2005](#)). Short-term economic pain will be negligible compared with the long-term consequences of 'business as usual'.

In Europe, the need to reduce greenhouse gas emissions is now widely accepted. The European Parliament, along with Africa, China and India, all accept the concept of 'contraction and convergence' (C&C) ([Meyer 2000](#)) which is consistent with the basis of the UN Charter that everyone in the world should have equal rights. It is also consistent with the principles of 'utilitarianism' as propounded by Jeremy Bentham, the founder of University College London. The basis of Utilitarianism is 'the greatest happiness for the greatest number'.

C&C starts with the premise that everyone should have equal rights to emit carbon pollution. The concept is so eminently fair that it has been endorsed by the Quakers and the Church of England. It has also been recommended by the British Chartered Insurance Institute report on climate change ([Dlugolecki *et al.* 2001](#)). However, if everyone had an equal allowance on a per capita basis to stabilize emissions to a safe level, this would involve limiting carbon emissions to 0.3 tonnes per person per year—about the amount emitted per passenger on a New York to London return flight ([Hillman & Fawcett 2004](#)). Currently, per capita carbon emissions average 20 tonnes in the USA, 10 tonnes in Britain and 1 tonne in India. The average US car alone emits its own weight in carbon every year.

But the real problem is not motor vehicles, which can easily be adapted to use carbon neutral bio fuels. The problem is buildings. Buildings are much less easy to adapt and account for more than 50% of carbon emissions just in

- (i) manufacture and transport of construction materials and
- (ii) heating, lighting and cooling.

Too often, sustainable architecture only refers to energy conservation. To be truly sustainable, a building should be designed to survive the sort of natural hazards which are going to become increasingly frequent and severe. In other words it has to be resilient, and it also has to be adaptable to other uses as society's needs change.

If a building is damaged by flood or storm, damaged materials have to be removed to landfill, and new materials be manufactured and transported. An architect may be tempted to favour form over performance, then walk away, leaving the property owner, the insurer and ultimately the environment, to suffer the consequences. They are allowed to do so by those responsible for building regulations who seem to have a blind spot about climate change impacts.

3. The role of the insurance industry in the UK

The insurance industry is very well placed to use financial penalties and incentives to architects, builders and property owners to produce buildings which not only help to mitigate GHG emissions, but are more resilient to natural hazards. The USA and the UK have very different approaches when it comes to government support for the survivors of natural hazards. The USA policy is very similar to the policies of the former Eastern Bloc communist countries in adopting the principle of 'solidarity' especially with those who suffer from floods and storms. Thus, government-subsidized insurance is available to those living in the most hazardous areas.

Thomas Jefferson, the author of the USA's Declaration of Independence, said 'The care of human life and happiness, and not their destruction, is the first and only legitimate object of good government' (Jefferson 1809). Many countries in addition to the USA have the ethos of solidarity in which the government helps citizens who suffer from natural and other disasters. This ethos is not so deep rooted in Britain; indeed a government minister (Raynsford 2000) went so far as to say in connection with government compensation for flood damage: 'That would not be a wise or sensible position for any government to take' (The Environment Transport and Regional Affairs Select Committee 2000).

In the absence of government compensation, one of the results is that there is a public perception that insurers have a 'social duty' to provide cheap cover for everyone (Clark *et al.* 2002).

There is a high take up of private insurance in Britain, and British insurers are much less strictly regulated than in the USA. This has meant that the insurers are financially strong and technically sophisticated in managing risks. In facing the challenges of climate change they are also becoming much more proactive.

4. Technology

Ninety three per cent of home owners in Britain have private insurance cover. British insurers have access to sophisticated catastrophe models and geographical information systems and databases which enable them to assess risk at individual address level. Many might be surprised to learn that until very recently, the biggest British insurance companies each had much better flood maps than the British government or its agencies can afford. (In the case of

Table 1. The elements of risk.

	flood adaptation	windstorm adaptation
hazard	engineered and soft defences. Warning systems	wind breaks, e.g. trees. Warning systems
vulnerability	resilient construction and design. Temporary defences	resilient construction and design
exposure	relocate away from flood hazard zones	avoid areas exposed to wind damage

coastal flood, they still do.) One British insurer has spent £5 million on an airborne survey of the whole of Britain using synthetic aperture radar to map the whole country at a much higher resolution and accuracy than the government's own mapping agency. In 2004, it handed over the results to the government's environment agencies to help them produce better river flood maps for publication. Architects and planners who ignore such maps potentially lay themselves open to litigation, and deservedly so.

5. The risk triangle

There are three elements of risk: hazard; vulnerability; and exposure (Crichton 1999). Adaptation measures can be applied to each of the components (see table 1).

Society needs to develop a culture of prevention and preparedness, rather than just react to events after they happen (Kumar *et al.* 2002). For example, communications systems collapsed in New Orleans and in Carlisle in 2005 at the very time they were most needed. It is not difficult to make such systems disaster proof (Webb 2006) so what is being done? In Scotland, the importance of resilient communications in a disaster has been recognized for years, and all base stations for mobile phones must be located in safe areas.

The insurance industry used to simply react to a loss and pay the claims. Now they are increasingly realizing that premium incentives and advice for reducing risk make good business sense (Crichton 2005a). In Britain they are even influencing public policy and funding research and data collection to reduce societal losses (Crichton 2005b), because that makes sound business sense as well.

6. Sea level rise

Climate change will have a major impact on London (Entec *et al.* 2003) in terms of social, economic and political changes as well as a much increased risk of property damage. For example, London is increasingly vulnerable to sea level rise. The Thames Barrier protects 150 km² of London that lies below the high tide level. Overall in London the value of property in the floodplain is around £80 billion (Parker & Penning-Rowsell 2002). The Thames Barrier alone protects property worth around £30 billion. In other words the exposure is very high. Hazard has been reduced by the Thames Barrier, but if the Barrier were to be put out of commission by accident, terrorism or sabotage, London could be at risk of flooding, although there are many precautions taken to prevent this happening.

The Barrier will protect the wealthy areas of London against the 1000 year flood until 2030, but it will have to be deployed more often. Since its completion in 1982, up until August 2001, it was closed 63 times. Most of these events have been in recent years: in the winter of 2000/2001 alone, it was closed 24 times, mainly in response to unprecedented freshwater flows.

As at January 2003, the Barrier had been closed a total of 82 times following its use in a record of 14 consecutive tides to help to alleviate fluvial flooding in the Thames catchment, when flows in the Thames reached their third-highest value, a more severe event than in autumn 2000 (when it had been closed for seven consecutive tides). By 2030, due to sea level rise and other factors, it has been estimated that it will need to be closed 30 times a year on average ([Environment Agency 2001](#)). It seems to be generally accepted that further protection will be needed at some point in the next 30–50 years. Therefore, the Environment Agency has extended its planning horizon by 70 years to the year 2100, and has started a project called ‘Planning for Flood Risk Management in the Thames Estuary’ to develop a strategy for the tidal Thames from Teddington to Sheerness/Shoeburyness. Preliminary estimates of the cost of providing a 1000 year standard in flood defences up to the year 2100 produce a figure of £4000 million which will need to be spent in the next 40 years.

Upstream, along the non-tidal stretch of the Thames, some 12 000 houses are within 500 m of the river bank, and their riverside location adds £580 million to the value of these properties ([McGlade 2002](#)). Along the tidal stretch of the Thames, 800 000 people live within a 10 min walk of the river.

London’s infrastructure is near full capacity, yet the growing demand for houses means that many more houses are to be built downstream of the Barrier in two major developments, the Olympic Village and the Thames Gateway (<http://www.thames-gateway.org.uk>). The Planning Framework estimates that soon Thames Gateway might provide over 110 000 new dwellings.

One aspect which may really cause insurers problems is that in the Thames Gateway area, it is planned to have a high concentration of dwellings: up to 200 dwellings per hectare compared with a normal level of around 30 dwellings per hectare even in southeast England.

While most of London may be well protected from coastal and river flood, there is still a problem with pluvial flooding from severe rainfall events. On 7 August 2002, an inch of rain fell in central London for 30 min during the evening ‘rush hour’, resulting in the closure of five mainline railway stations and considerable disruption. London’s Victorian drainage infrastructure is too old and overloaded to cope with such events. More than 50% of drainage and sewage overflow problems in England take place in London ([Crichton 2005b](#)).

7. Storms

Climate change will have major impacts across Europe ([European Environment Agency 2004](#)), and hail storms and windstorms will be a particular problem. Underwriters should be concerned that climate change may result in winter storm tracks moving south ([Dronia 1991](#)), as happened with the very damaging storms of 1987, 1990 and 1999. Fortunately, so far England and France have escaped a storm of the severity of the Braer storm which hit Shetland in 1993.

This storm nearly broke the European record for low pressure with atmospheric conditions similar to a category 5 hurricane; not only that, it lasted 22 days. Despite its severity, the buildings in Shetland are constructed so well that there was very little damage. If such a storm were to hit highly populated areas of England and Wales, there would be widespread devastation and loss of life, due to much lower building standards. Already, the number of winter storms crossing the UK mainland has doubled in the last 50 years (Hadley Centre 2003).

Little can be done about the hazard or exposure sides of the risk triangle for storms, so it is important to concentrate on the vulnerability side. As the 1993 Shetland storm showed, if buildings are sufficiently resilient, they need not suffer damage from storms. The question is whether architects, the construction industry and government can be persuaded of the need to consider more resilient construction methods. Insurers could help by pooling statistics on storm claims to help to identify which parts of buildings fail, and the author is trying to get the modest funding needed to enable this. So far only a pilot study has been done, but that has found that modern buildings are much more vulnerable to damage than older ones, mainly because older buildings were 'over engineered' while modern ones are built to building standards and codes which are not sufficiently resilient, at least in England and Wales. One problem is that architects and the construction industry are under pressure to produce quantity rather than quality, as demand exceeds supply. For the cost of an average new house, a rich source of data from insurers could be collected and analysed to show precisely what changes are needed to building standards, and thereby significantly reduce storm damage losses in the future.

8. Floods

Climate change is already increasing the number and severity of floods across Europe. Britain is one of the few countries in the world where most of the population have private flood insurance (Crichton 2002), but this may change as insurers adopt new strategies. Many people welcome the 'natural look', of rivers and coasts and so long as cheap insurance has been available, people have been prepared to live in flood hazard areas and put up with occasional flooding in order to have the amenity which a river or beach offers. There have even been a number of cases where residents in England have refused flood defences because it would spoil their view of the river, for example in Bradford upon Avon (which subsequently suffered from serious flooding).

In the upper reaches of the Thames, waterfront property values are on average £48 000 higher than comparable properties elsewhere (McGlade 2002). This desire for the amenity value of living by a river is quite understandable, so long as such people do not expect to be subsidized by cheap flood insurance rates.

In 1961, the insurance industry in Britain voluntarily agreed with government that they would guarantee to offer affordable flood cover for all households regardless of risk. This 'insurance guarantee' has distorted the market for 40 years, and is no longer sustainable, at least in the South East of England, owing to the high demand for housing and the shortage of suitable land, leading to an enormous growth in floodplain development. It has meant that government in England and Wales has taken it for granted that flood insurance will be

available, and has not felt the need to consult the insurance industry before going ahead with major developments in flood hazard areas such as the Thames Gateway for example. In one year alone, there were over 600 new building projects, mainly residential estates, given planning permission against the advice of the Environment Agency in England and Wales due to fears of the flood hazard.

When the English government introduced draft new planning guidelines in December 2005, which would continue to encourage flood plain development, the insurance industry almost immediately reacted with an announcement that from January 2006 it would start to 'blue line' flood hazard areas for new and existing homes. Some 350 000 homes are now potentially uninsurable and becoming blighted. Perhaps the government has taken insurance for granted for long enough.

Meantime, some planners have been listening to the warnings from the insurance industry and taking local action for some years. The 'insurance template' devised by the author ([Crichton 1998](#)) in 1997 is based on actuarial calculations and has been widely adopted by planning authorities covering about 40% of Britain.

It shows risk levels in the form of return periods where insurers are prepared to offer flood insurance at normal premium levels.

9. The insurance template

Hospitals, senior citizen homes, etc.	1000 years
Hotels, hostels, children's homes, etc.	750 years
Basements	750 years
Single storey homes without roof escapes	500 years
Near rivers which can flood suddenly	500 years
All other residential	200 years

Until recently, public perceptions of flood risk have been reduced by subsidized insurance premiums, and as these perceptions of risk increase, along with higher premiums, problems in obtaining insurance and consequent reduced property values, there is likely to be more demand for engineering flood defence solutions because they are quick and visible. Yet such solutions are expensive to build and maintain. According to government research, an investment of £52 000 million may be needed just to manage the additional risks of climate change this century ([Evans & Hall 2004](#)). The position has already been reached where the flooding problems in England and Wales are going to get a lot more costly unless some drastic action is taken.

Insurers have pooled their flood claims details, which has enabled the publication of figures ([Black & Evans 1999](#)) for average costs of flood claims by depth and type of property. The British Flood Insurance Claims Database is the biggest of its kind in the world, but again needs some modest funding to maintain it. Individual insurance companies have taken it in turn to fund it, but funding really needs to be put on a firmer footing. Data from this database could help to change building standards so that buildings are more resilient to flooding, thus reducing the costs of flood events.

10. Human impacts of floods

After Katrina, harrowing images were shown of the human misery caused by the floods. Research in Britain (by Professor Parker, Middlesex Flood Hazard Research Centre, UK) has shown that there are both physical and mental effects on flood survivors. Flood water is often contaminated with sewage, and 20% suffered gastrointestinal diseases for example. The mental effects can be more widespread and pernicious: 80% of flood survivors feel anxious whenever there is heavy rain, 9% have felt suicidal.

In a wealthy, civilized society, when are architects, planners and property developers going to realize the consequences of their actions?

In the meantime, more people will have to resort to buying their own temporary flood barriers to give them some peace of mind (Crichton 2004).

11. Conclusions

The first priority must concern the location and design of future buildings and cities. Locations should be in areas least exposed to severe weather and sea level rise, and buildings should be designed to be resilient and to minimize carbon emissions and vulnerability to the elements, including damage to infrastructure such as transport and power supplies. If this were done now, then there would be fewer problems for future generations. Insurance and reinsurance companies have the risk management, computer modelling and GIS skills, together with the data to help to reduce risk, and they also have the economic power to create financial incentives to encourage it to happen. More consultation with insurers by architects and planners, combined with some very simple and cheap measures by government could bring a huge amount of insurance expertise to the table to reduce problems in the future.

The author has already been involved in some of these issues in other parts of the world and is often invited to address architectural students and land use planning students to help to get the message across. For more details of the message, see *Adapting Buildings and Cities for Climate Change* (Roaf *et al.* 2005) a groundbreaking textbook designed for the architects of the future.

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