

## **UK Household: Floods, Inflation and Under-Insurance**

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### **Summary**

1. With the exception of the severe floods in October 2000, recent Household claims experience has been benign. However, this is deceptive; the underlying cost of Household claims has been increasing rapidly, fuelled by rising domestic consumption and a shortage of skilled labour to perform building repairs.
2. The rapid growth in Household costs has been offset in recent years by declining theft and subsidence claims. These have now stabilised. We believe that Household claims costs per policy will start to rise strongly, and that substantial premium increases are going to be required to maintain the current level of profitability within the UK Household insurance market.
3. The traditional approaches to indexing Sums Insured for Buildings and Contents cover have failed to capture the growth in insured risk within the market in the last decade, and as a result we believe that the UK Household market is systematically under-insured.
4. The increasing cost of flood claims, and new technologies allowing ever more granular approaches to insurance rating will mean that a number of properties currently insured for flood risk under the ABI moratorium may soon find it difficult to obtain flood cover.

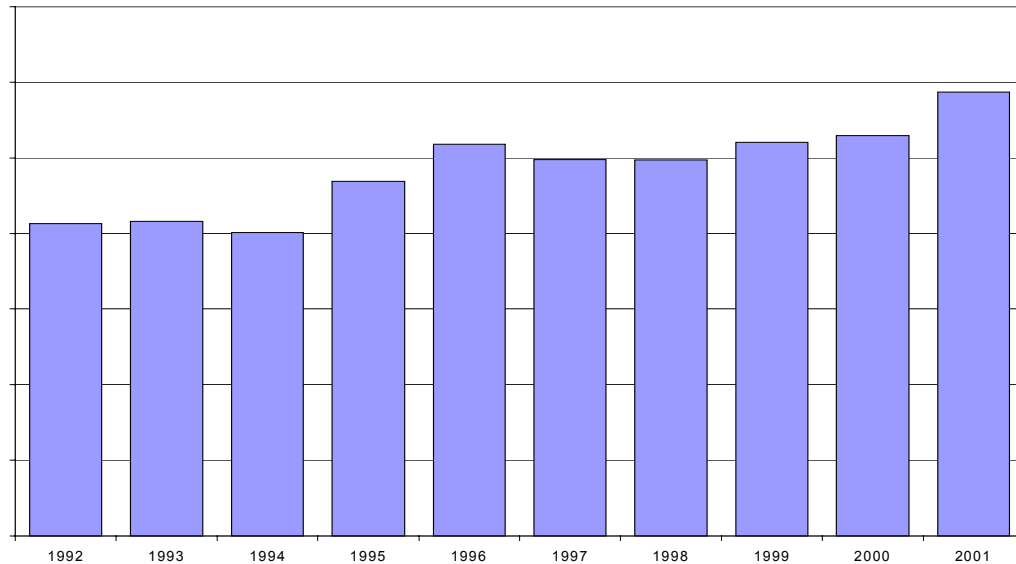
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## 1. Analysis of Recent Claims Experience

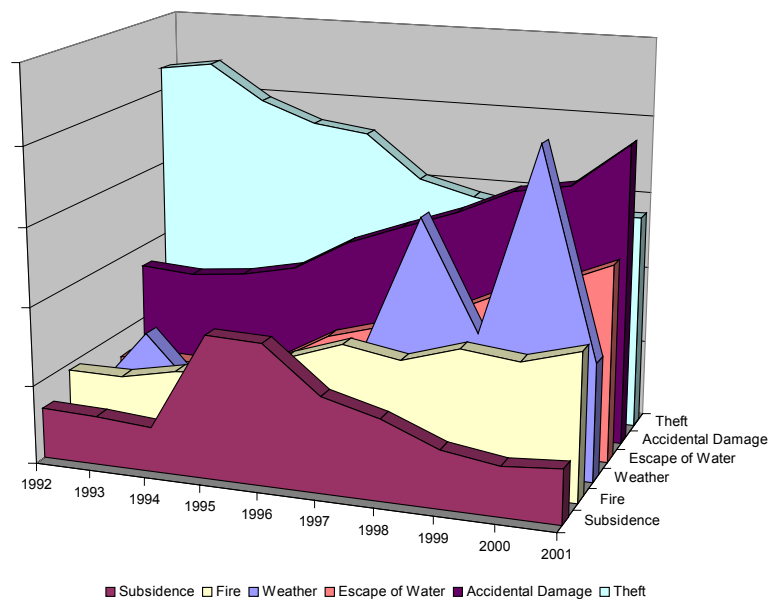
If we exclude the volatile cost of weather-related claims, Household claims experience has been benign over recent years. Claims cost per policy increased sharply in 1995 and 1996, but has been largely unchanged since then.

Household Burning Cost Excluding Weather 1992-2001



However, this apparent stability in claims costs is deceptive. The graph below shows claims costs by peril for the last ten accident years.

Household Claims Cost by Peril 1992 - 2001



A number of features are immediately apparent.

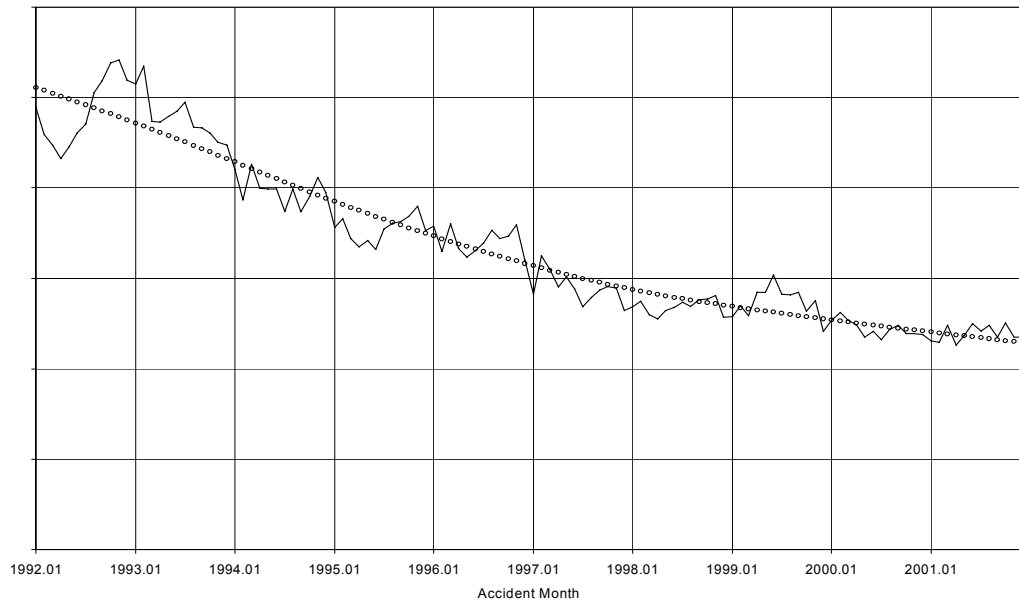
1. Subsidence claims peaked sharply in 1995/96 and have declined gradually since. The sharp increases in the claims cost per policy over 1995 and 1996 are clearly due to the spike in subsidence costs in these years.
2. The cost of Theft claims has declined steadily. Ten years ago they made up 50% of the total Household claims bill; in 2001 they were only 20% of the total.
3. The cost of Fire, Accidental Damage and Escape of Water claims has grown inexorably, and these perils now make up over 50% of the total claims bill.

The following pages set out in more detail the claims experience by peril and investigate the drivers of that experience. The analysis is based upon sections of the Norwich Union Household account.

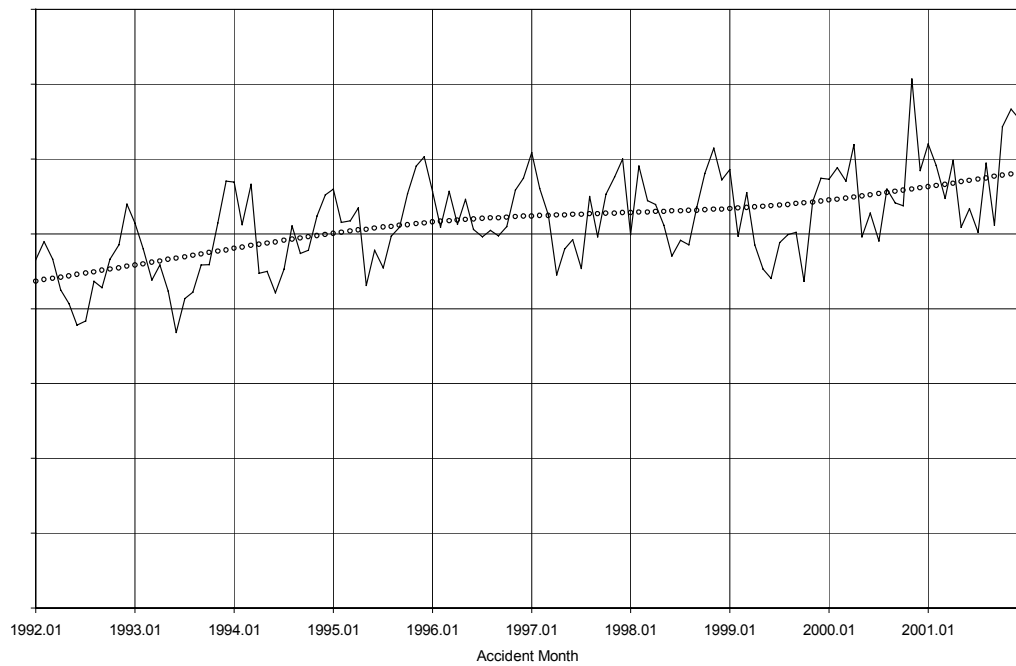
## Theft

The graphs below show the frequency and average cost of Household Theft claims by accident month from 1992 to 2001.

Theft Frequency 1992 - 2001

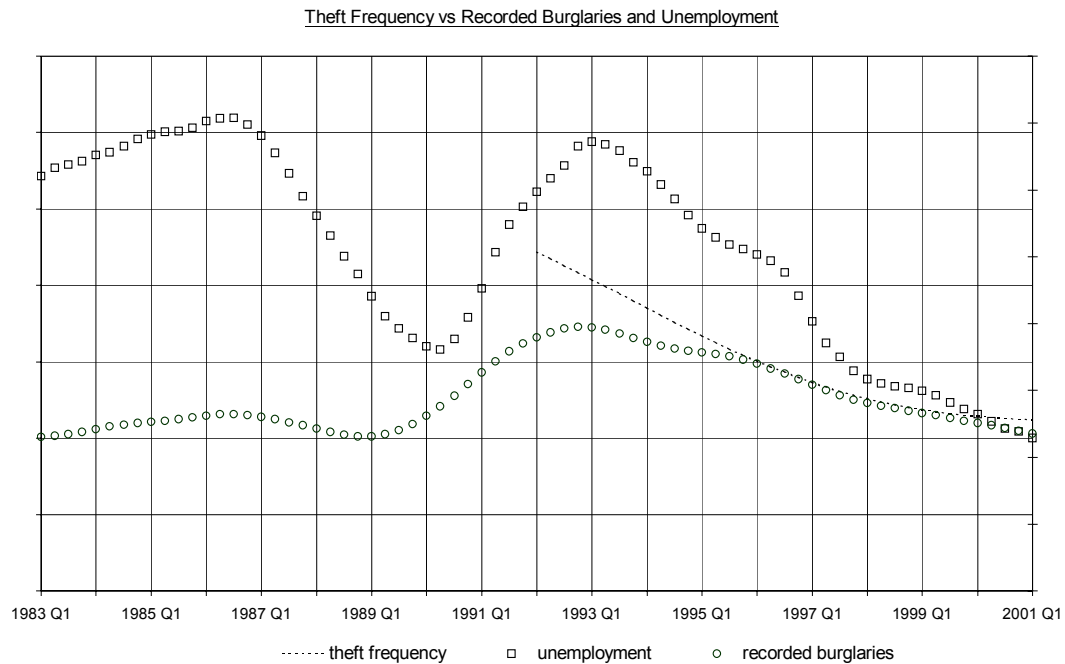


Average Theft Claim 1992 - 2001



Over the last ten years, Theft frequencies have declined steadily. This phenomenon is well documented; there is a strong correlation between the number of burglaries and the level of unemployment. Doubtless there will be other contributory factors, such as the increasing prevalence of double glazing and better home security generally.

The graph below compares theft frequencies with the level of unemployment and the numbers of recorded burglaries.

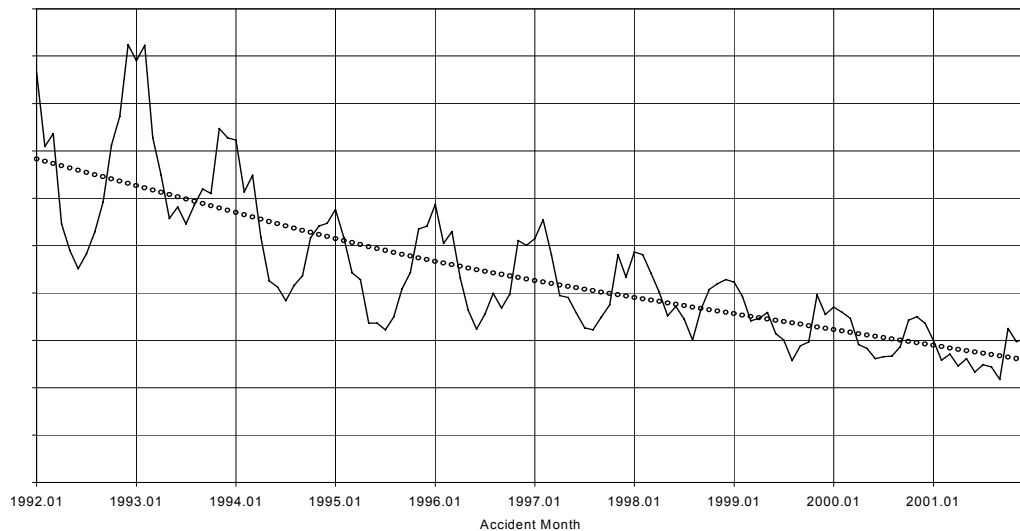


The simultaneous decline in unemployment, the number of recorded burglaries and in Theft frequencies is clear. It is also clear that the rate of decline has been slowing, and indeed the frequency of theft claims has now levelled out.

## Interesting Facts about Theft Claims

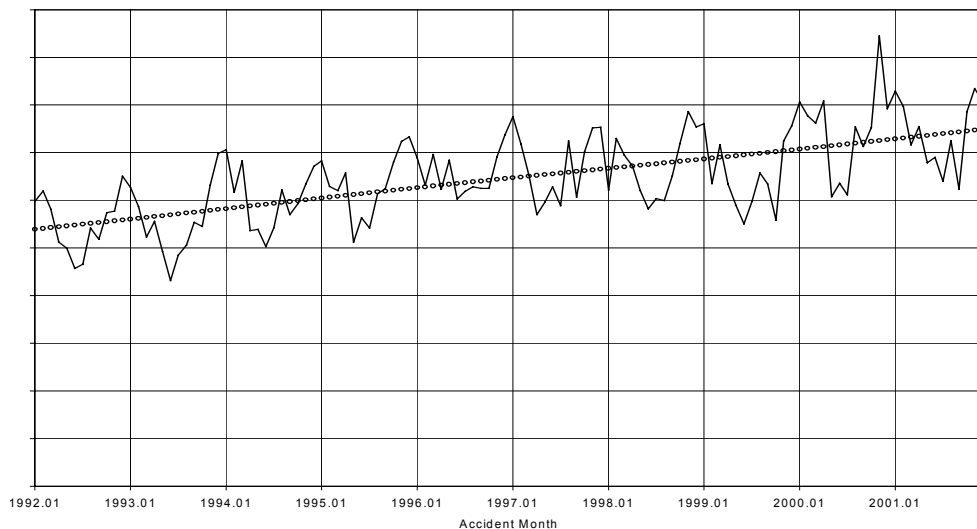
The frequency of Buildings Theft claims shows marked seasonality, with more claims occurring in the winter months. This may be because people leave windows and doors open in the summer, and so fewer summer theft claims involve damage to buildings. There is no strong seasonal pattern in the frequency of Contents Theft claims.

Theft Buildings Frequency 1992 - 2001



The average cost of Contents Theft claims is also highly seasonal: those in the winter cost more than those in the summer. This is presumably the inverse of the previous point; summer claims involve more opportunistic thefts through open windows and doors, which are presumably relatively small, while the dark winter months give thieves more opportunity to do a thorough job (and there may be expensive Christmas presents lying around). There is no such pattern for Buildings claims; a physical break-in costs the same at any time of year.

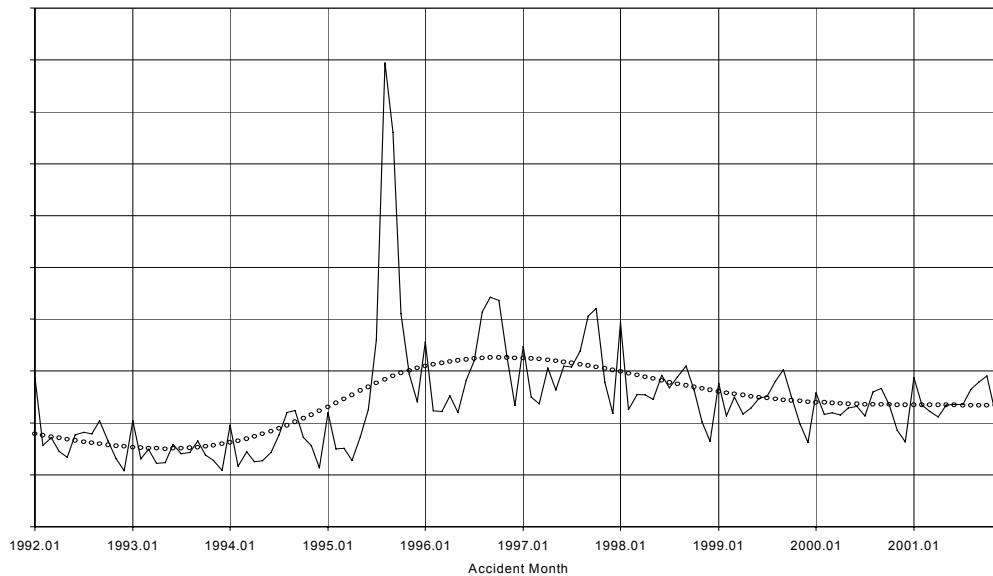
Average Contents Theft Claim 1992 - 2001



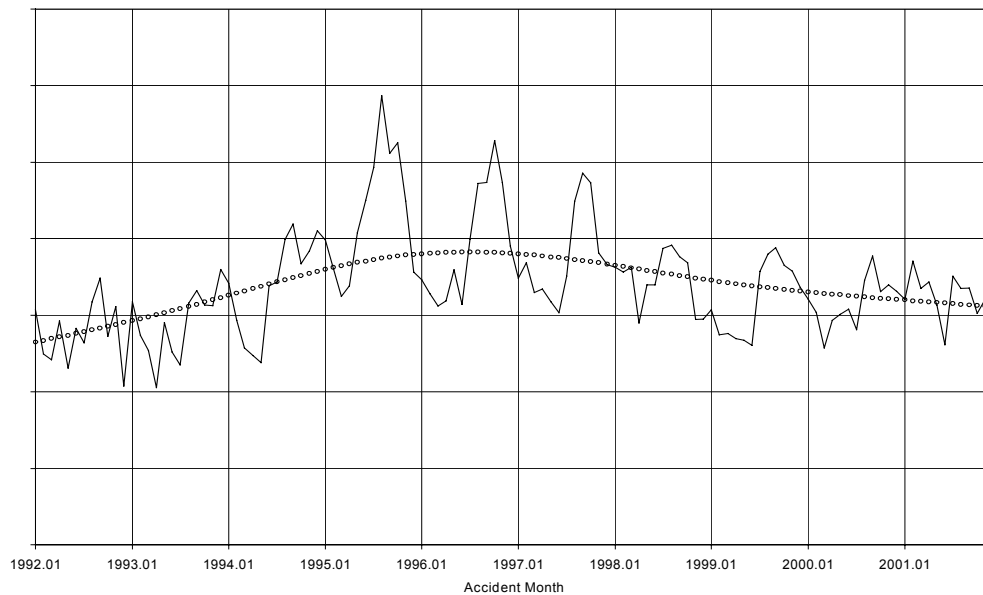
## Subsidence

Both the frequency and average cost of subsidence claims increased markedly in the mid-1990s and have gradually declined since. They are shown by 'accident' month, although the event date of subsidence claims is ill-defined, and is often recorded as the date of notification of the claim.

Subsidence Frequency 1992 - 2001



Average Subsidence Claim 1992 - 2001





A principal cause of subsidence is soil shrinkage around the foundations of the property. This is typically caused by the soil drying out, for instance because of a large and thirsty tree planted close to the building, or because of protracted periods of low rainfall. (This explains the seasonal pattern in subsidence claims, the bulk of which are notified in the autumn, following the dry summer months.)

The mid-1990s enjoyed particularly dry summers. The graph below compares the actual subsidence cost over the last ten years with a model fitted to rainfall over March-September in each year. The model used is of the form:

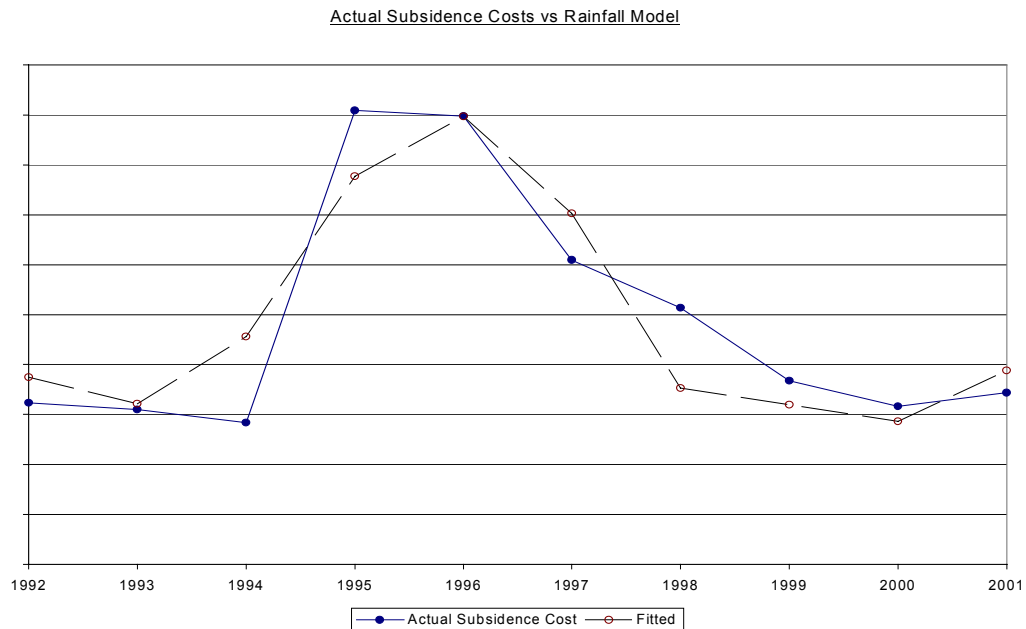
$$S_t = A - B.R_t - C.R_{t-1},$$

where

$S_t$  = subsidence cost in year  $t$ ,

$R_t$  = March-September rainfall in year  $t$ ,

$A, B, C$  are fitted constants.



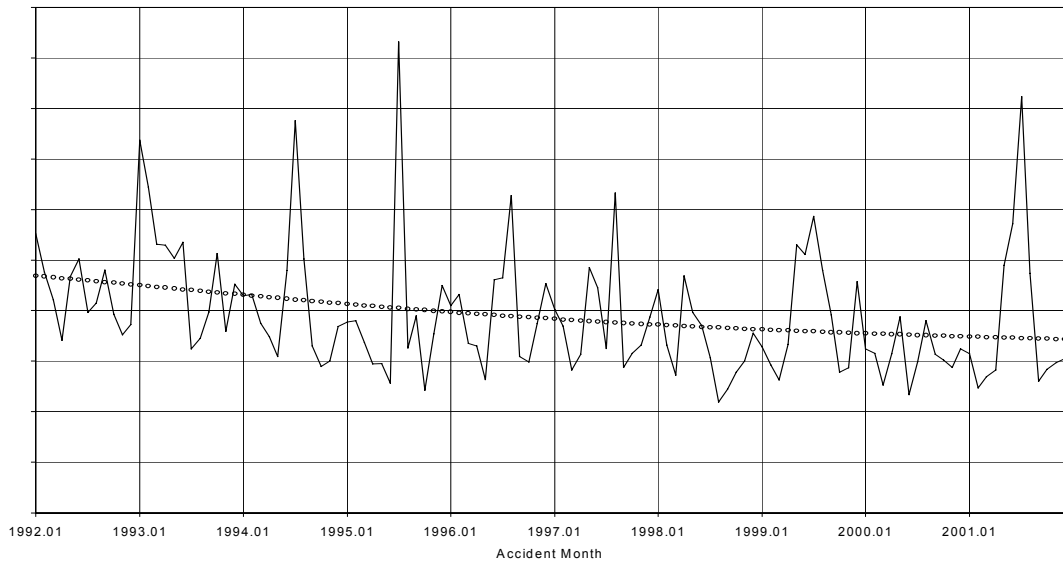
(Thanks to Richard Skelding for this work. The analysis uses the England and Wales monthly precipitation figures from the Hadley Research Centre, which is currently based upon weighted averages of daily observations from a network of stations in five regions.)

The fit is not perfect, and the model predicts an increase in 2001 subsidence costs which did not materialise; however, the strong inverse correlation between the amount of Summer rainfall and the cost of subsidence claims is clear. Note of course that the real driver of subsidence is not so much the amount of rainfall as the level of moisture within the soil.

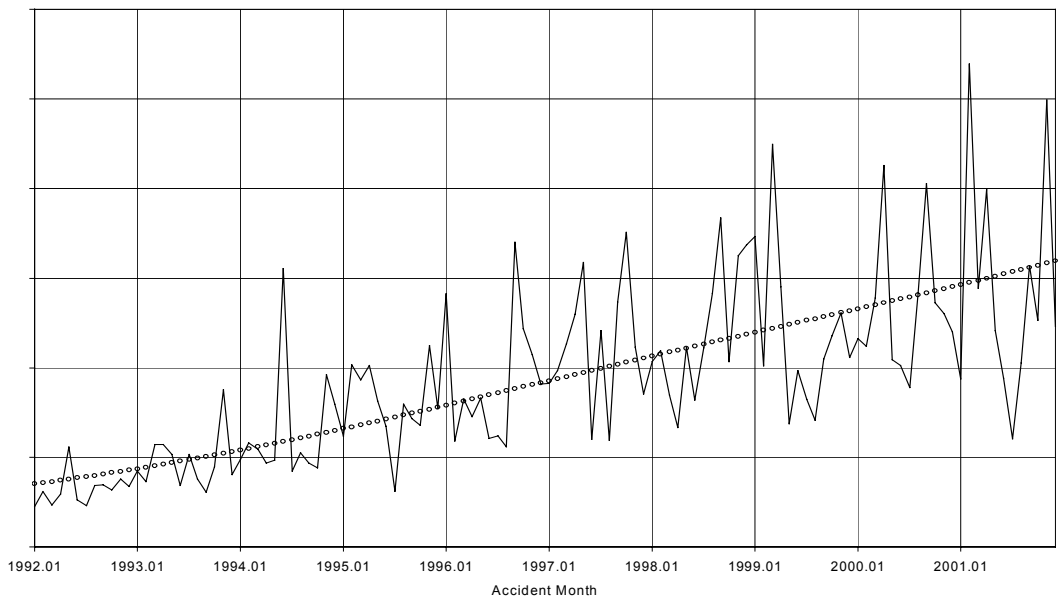
## Fire

Household Fire claims experience is volatile and difficult to interpret. The frequency of Fire claims appears to have been broadly stable over the last ten years, but their average cost has increased markedly. It is hard to say whether this is genuinely a trend; however, as we shall see in later paragraphs, there is strong evidence that the cost of claims involving Building repairs has been increasing rapidly.

Fire Frequency 1992 - 2001



Average Fire Claim 1992 - 2001

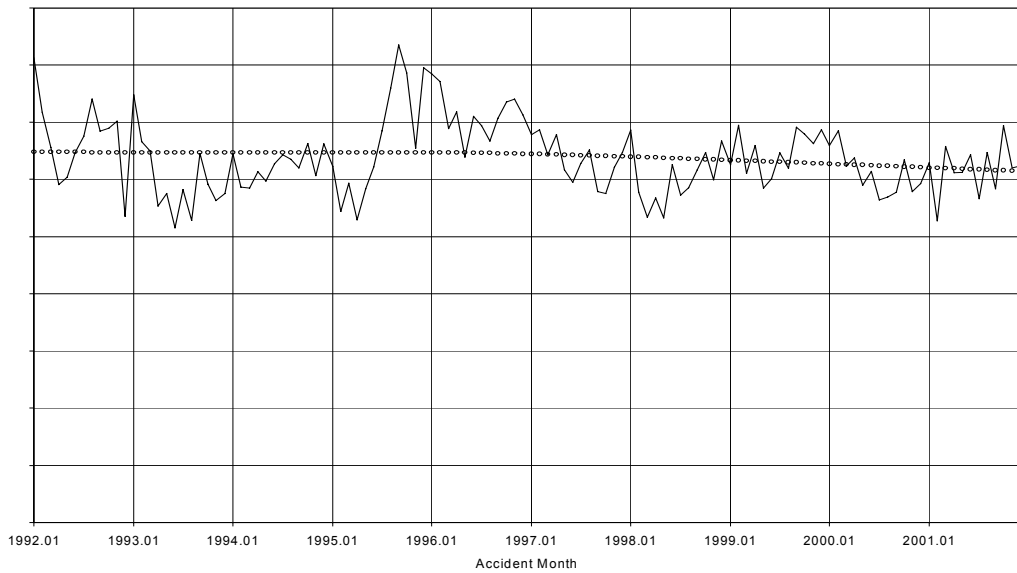


## Accidental Damage

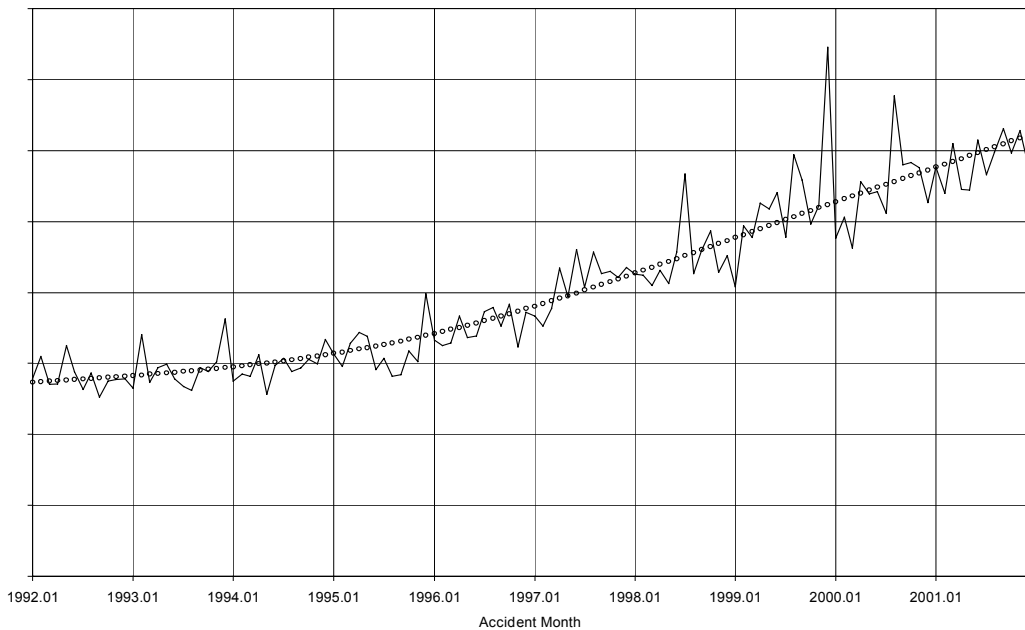
The rate of inflation observed in Accidental Damage claims over the last seven years has been remarkable (9% p.a.). The majority of these claims relate to Contents cover, where Accidental Damage cover is often bought as an optional addition to the standard policy.

We shall discuss in the next section the factors which may be driving this apparent inflation.

Accidental Damage - Frequency

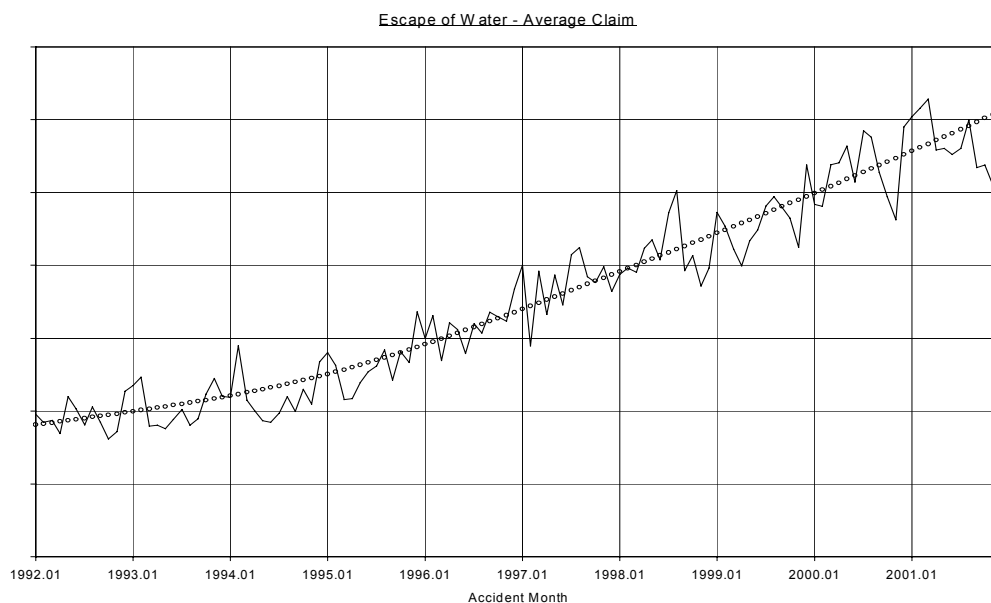
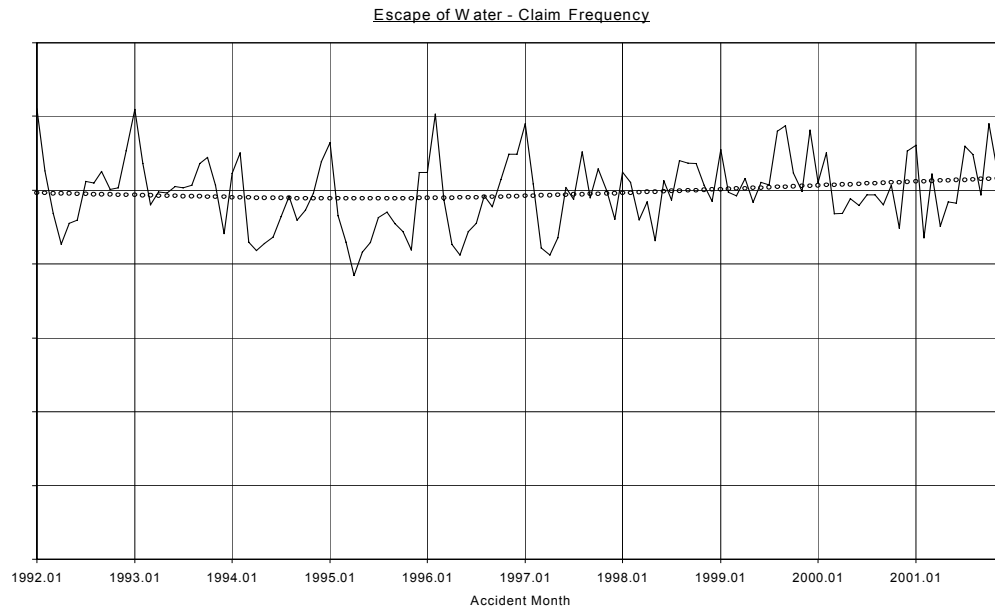


Accidental Damage - Average Claim



## Escape of Water

We exclude in our discussion of 'Escape of Water' claims those due to burst pipes following a freeze event. There is invariably a degree of miscoding when claims are recorded onto the claims systems; we have removed the most obvious offenders from our Escape of Water data and assigned them instead to freeze events.



The remaining Escape of Water claims are largely due to flooding caused by washing machines, drains and so on. Remarkably, these amounted to almost 20% of the total Household claims bill in 2001.

Again, the rate of inflation in recent years (13% p.a.) has been phenomenal.

There was much excitement in the Press a few years ago about 'Pitch Fibre' pipes (e.g. BBC August 1998 "**Crumbling Sewers Spark Rats Boom**"). These are drainage and sewer pipes widely used in the 1960s and 70s, made from an unlikely-sounding combination of tar and straw. Unsurprisingly perhaps, these have started to break down. An insurance Armageddon was predicted, with the nation's drains collapsing in a tarry heap.

We have investigated Norwich Union's claims experience to see whether this particular feature has been causing the inflation in Escape of Water claims, but have found no such evidence. The Armageddon may still be there, but it has not yet materialised.

There however (at least) two phenomena which may explain it. One is the increasing trend in recent years towards the use of more exotic, and more expensive, floorings, such as laminated wood or 'natural' carpets. Another is the cost of labour in buildings repairs. Again, this will be discussed in the following section.

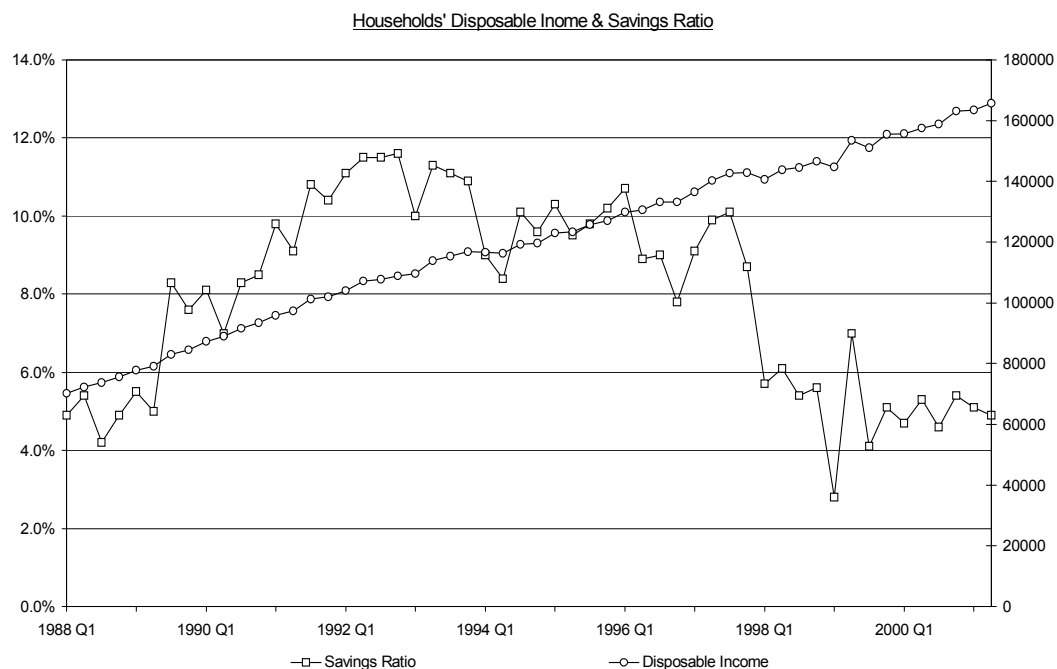
## 2. Indexation of Sums Insured

The amount of risk insured by a Household policy is often measured by the 'Sum Insured'. For Contents insurance this represents the value of the contents of the home, for Buildings cover it represents the rebuilding cost of the property. The Sum Insured is 'indexed', or adjusted at each policy renewal to reflect inflation in the cost of repairing or replacing the insured articles.

### Contents Insurance

What has been driving the inflation in Contents claims costs in recent years, and how do the measures of indexing Household exposure (the Sums Insured) cope?

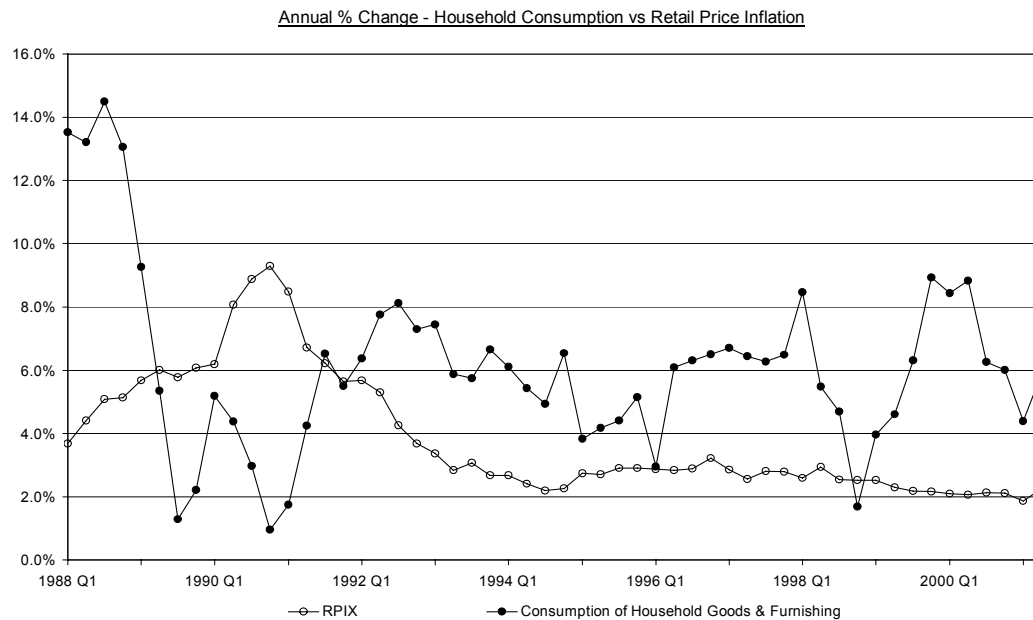
The last ten years or so have seen a period of sustained prosperity, with falling unemployment, rising household incomes and low inflation. In addition, people have been saving less and spending more. The graph below shows UK Households' disposable incomes since 1988 and the savings ratio (the proportion of disposable income that is saved rather than spent).



Households' disposable incomes have been rising steadily over the period. Moreover, since 1992 the savings ratio has fallen from almost 12% to around 5%. People have been earning more and saving less.

Much of this increased spending has gone on leisure services: foreign holidays, alcohol and eating out, and gym membership in an attempt to mitigate their effects. However, a substantial proportion has gone on goods for the home.

The graph below compares the rate of increase in UK Households' consumption of Household goods and furnishings with Retail Price Inflation (excluding mortgage repayments).



Whilst RPI has been running at between 2% and 3% p.a. for much of the last decade, consumption of household goods has been increasing at around 6% p.a.. We believe that this increasing consumption may explain much of the increases in the cost of Household AD claims. Whilst the prices of televisions and electronic goods, for instance, have been falling in relative terms for many years, people have been replacing their old TVs with 26" wide-screen affairs, and have added DVD players and Home Movie equipment. We all own much more, and more expensive, stuff than we did a decade ago, and the cost of replacing or repairing our belongings has risen accordingly.

Have our Contents sums insured kept pace? As mentioned earlier, the practice for indexing Contents exposures varies widely; however, many companies use measures related to RPI. **As the graph above shows, this has not captured the rate of increase in the amount of insured goods at risk.**

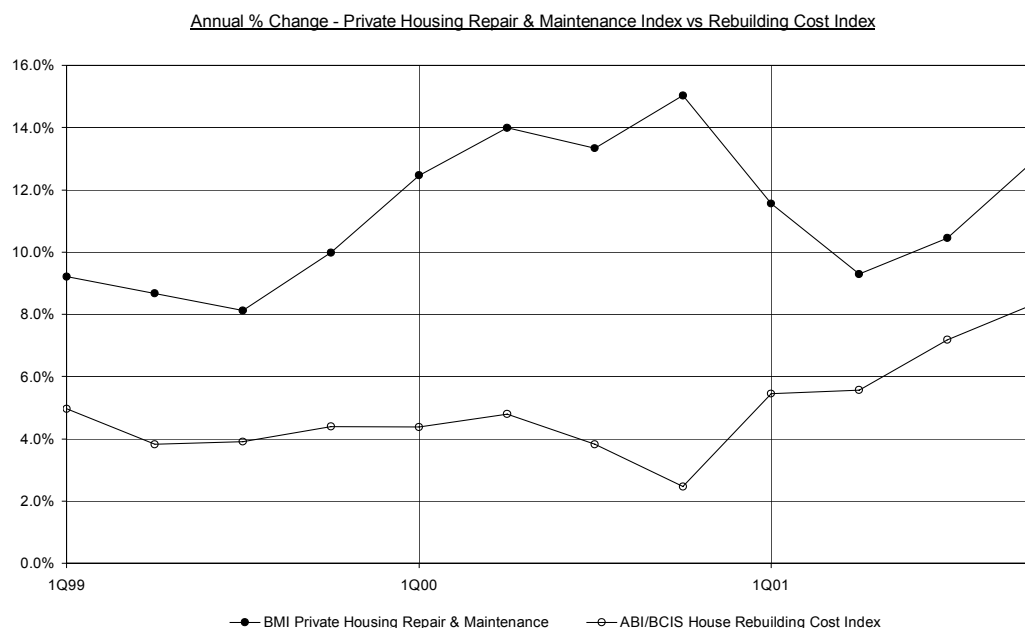
## Buildings Insurance

Sums insured under Buildings policies are typically indexed in line with the House Rebuilding Cost Index, prepared monthly by the Royal Institute of Chartered Surveyors for the ABI. The index is based upon the average rebuilding costs of a variety of houses. It does not allow for specific variations due to region or construction type, and the RICS recommends that sums insured be recalculated every five years to allow for these variations by region and house type. Separate cost guides, commissioned by the ABI, are published by the RICS to allow policyholders to do this, although in some regions and for some construction types these guides are not applicable and a surveyor is needed.

The flaw in using the House Rebuilding Cost index as a measure of the growth in insured risk is obvious: very few claims involve the wholesale reconstruction of the property; most involve relatively minor repairs.

The RICS publishes a plethora of indices relating to costs in the UK building trade. One of them, which on the face of it appears to be much more relevant to the growth in the cost of buildings insurance claims, is the Private Housing Repair & Maintenance Index. This measures the cost to the customer of repairs to privately-owned housing, based on the rates charged by a sample of around 3,000 small building contractors.

The graph below compares the increases in the ABI/RICS Rebuilding Index with those in the Private Housing Repair and Maintenance Index over the last three years (indices courtesy of RICS Building Cost Information Service Ltd.).





The difference is striking; whilst the Rebuilding index has increased by around 5% p.a., the Repair & Maintenance index has risen by over 10% p.a. over the same period.

Is this sort of inflation in contractors' costs plausible? Anyone who has had to call out a plumber, for example, can testify that they are extremely hard to get hold of and are expensive when you finally manage to get hold of one. As discussed in the previous section, the last ten years have seen a period of protracted prosperity and rising consumption. There has undoubtedly been a lot of building activity, and it is easy to imagine that a shortage of skilled labour has led to spiralling costs. The CBI recently called on the Government to reduce the emphasis on Higher Education and encourage more school-leavers to enter the skilled manual trades.

This does not constitute a proof that the double-digit inflation seen in Escape of Water claims is due to the rapid increase in labour costs; however, this does appear to be confirmed by our investigations of the evidence from NU's Household account.

#### What happens next?

We can postulate two economic possibilities over the next couple of years:

##### 1. Continued economic growth

So far, UK consumers appear to have been largely indifferent to the malaise affecting world stock markets. Domestic consumption has been strong, although poor retail sales figures in May and June may signify the beginnings of a change. There remains a shortage of skilled manual labour in the UK economy. These factors are likely to lead to continued growth in the value of insured risk within the home, and in the cost of obtaining buildings repairs. These will no longer be subsidised by theft and subsidence costs, which have now levelled out.

##### 2. Recession

The alternative is a more gloomy economic outlook. We might expect this to dampen demand within the construction industry and reduce the upwards pressure on labour rates, at the same time as slowing the growth in the amount and value of insured goods in the home. This should reduce the underlying rate of inflation of Household claims, but rising unemployment may lead to increased theft!

**Either way, we believe that substantial increases to Household premiums will be necessary to maintain the current level of profitability in the UK household market.**

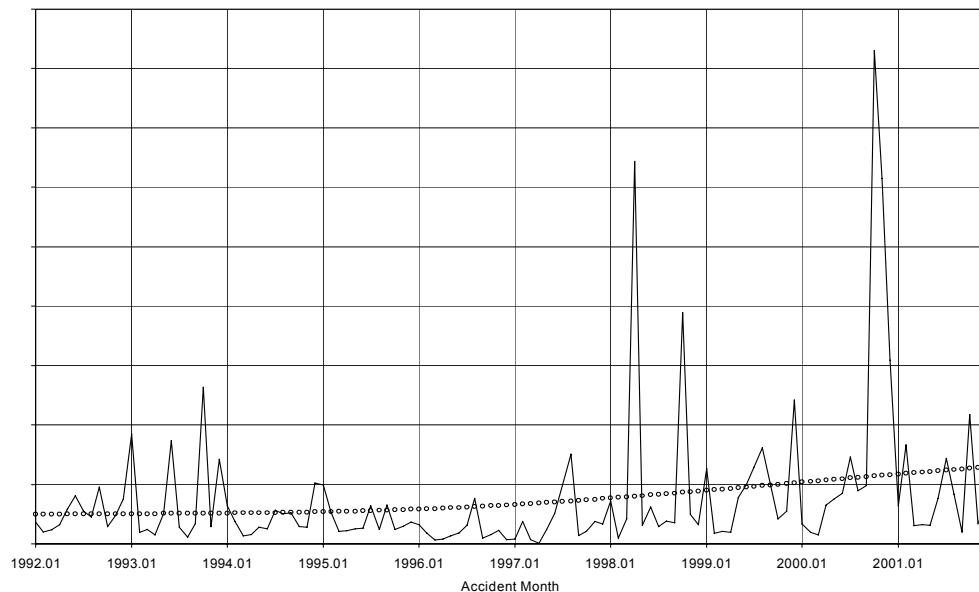
### **3. Flood Risk**

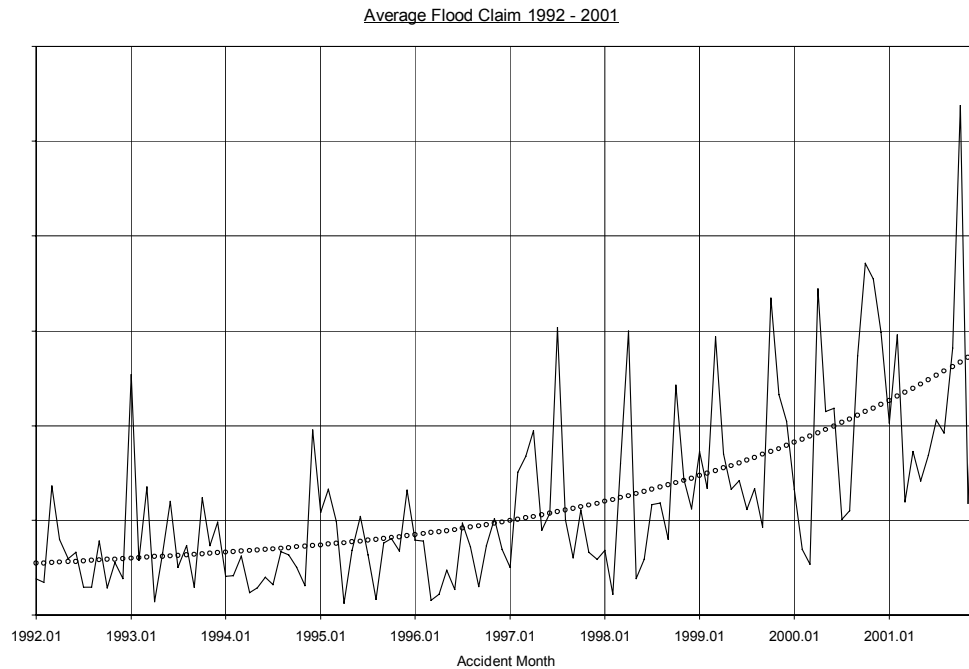
Insurers introduced flood cover as standard into household policies in 1961 at the request of the Government, following the significant flood events of the previous two decades. Prior to this, the Government had managed the financial impact of flooding via a system of disaster relief aid. The move from public to private coverage left the Government free to channel those funds to flood defences rather than flood relief.

Over time, the level of spending on flood defences has decreased in relation to the rate of deterioration in existing defences and in the amount of property exposed to flood risk (e.g. due to construction of new housing on flood plains). Nearly two million homes (equivalent to the entire population of the South West of England) and 130,000 commercial properties, worth over £200 billion, are at risk from flooding (DEFRA 2001) and over one million hectares of farming land, worth £7 billion, are also at risk. (MAFF July 2000).

In addition, global warming is predicted to produce more turbulent weather, with milder winters, stronger winds and more sudden, heavier rainfall. It is hard to assess this increased risk from historical experience. The graphs below set out NU's flood experience over the last ten years. It does appear to be the case that both the frequency and average cost of 'attritional' flood claims in the last five years have been substantially higher than those in the previous five, but of course this time scale is minute in the context of climatic change.

Flood Frequency 1992 - 2001





The floods in the Autumn of 2000 brought matters to a head. This was the wettest for 270 years; over 10,000 properties in 700 locations were flooded, at an insured cost of £1bn.

### ABI Flood Moratorium

The Government was concerned that flood insurance cover might cease to become readily available and entered into discussion with the ABI. The outcome of this was a two year moratorium on flood cover. The moratorium is not binding on members but has generally been adhered to. The main points are:

- Insurers will continue to provide flood cover to existing domestic and small business customers
- There will be no restrictions on pricing, i.e. cover will be available but it may be at a high cost or with a significant excess
- Cover may be declined where residents have refused to accept a flood alleviation project, the building is on a flood plain with no defences or the flood risk has worsened and no flood defence plans are likely to be in place in a reasonable period.
- The moratorium ends at the end of 2002

To date there have been several cases highlighted in the press about premium increases but to date very few problems with people obtaining renewal cover.

The insurance industry has identified three priorities for Government action:

- greater investment in flood defences
- radical curtailment of development in flood risk areas; and
- faster and more consistent decisions on flood defences

If these issues are not addressed then there is a real risk that insurers will cease to offer affordable flood cover in many areas.

Insurers are beginning to break away. Esure recently announced that it will no longer insure properties in certain areas and some insurers will not offer cover to new customers in flood-prone areas.

### Insurance Industry Action

The Insurance Industry has entered into public debate with the Government regarding the state of the nation's flood defences. In November 2001, the ABI called for increased investment, of a minimum £145m p.a., on flood defences. It also called for defences to be built to a standard of 0.5% (i.e. designed to withstand a flood event of a magnitude expected to occur once in two hundred years) to avoid dramatic rises in insurance premiums to reflect the risk in certain areas. Current DEFRA flood defence standards range between 1.0% and 1.3%. However, DEFRA's own reports show that many existing defences are below those standards, without taking into account the effects of climate change.

Whatever action is taken to improve flood defences, recent flood events have highlighted the need for far more localised rating of risks if flood insurance is to continue to be provided as part of standard household policies. To this end, the ABI and the insurance industry have commissioned research into various aspects of flooding. Individual insurers are also carrying out their own research. Norwich Union is working on establishing a digital map of the UK that will give height readings to an accuracy of down to 0.5m at 5m intervals.

DEFRA recognises that Environment Agency maps need to be improved for all interested parties to have a shared understanding of flood risk – but that these maps will take time for the EA to produce. The work underway to establish a DEFRA/EA database on flood defences was scheduled to become available at the end of 2002 and insurers will have early access to it before it goes public.

### Government Action

The ABI moratorium recognised that the Government could not solve the flood problem overnight, and the 2 year period was intended to give the Government time to act. During this period the Government has been active on various fronts.

In 2001, the National Audit Office reported on Inland Flood Defences. It commented on the complexity of arrangements for the provision and funding of flood defences and the worrying condition of many flood defences.

Revised planning guidelines (PPG25) were issued in July 2001. These were issued to local authorities and cover developments in flood risk areas. Essentially they state that flood risk is a material consideration in granting planning permission and that a risk-based approach should be adopted – the safest sites should be used first. PPG25 is not a statutory requirement, so it remains to be seen the extent to which Local Authorities will adhere to it.

(It should be noted that the situation is a little different in Scotland. In 1996 Scottish national planning guidelines for flood advised developers to consult with insurers to see if insurance will be available before planning consent is given.)

In the last twelve months the Government has commenced work on the National Flood and Coastal Defence Database and invited insurers to input to the Flood and Coastal Defence Funding Review.

DEFRA and the Environment Agency have highlighted the need to re-evaluate the criteria used to identify which areas receive flood defence investment, taking into account all the impacts of flooding. The Flood Minister has already announced changes to the priority scoring system to reflect the number of people protected, and the issue is under consideration by the Flood and Coastal Defence Funding review, the results of which are due in Autumn 2002.

## The Comprehensive Spending Review

The latest Government research on investment needs is set out in the 'National Appraisal of Assets at Risk from Flooding and Coastal Erosion, including the Potential Impacts of Climate Change', published in July 2001. It said:

- Over £300m pa is needed to maintain defences to current standards
- An extra £30m pa needs to be spent to improve defences to meet DEFRA flood defence standards
- Between £84m and £204m extra is required to take some account of the likely impact of Climate change

The call by the ABI for a minimum of £145m pa was based upon the middle of this estimate range.

The Chancellor of the Exchequer made his statement on the Comprehensive Spending Review on Monday 15 July. The key points are detailed below:

The Government has committed an increase in investment for flood and coastal defences to £150m per year by 2005/6. Furthermore, it has recognised the need for further non-funding measures to deal with the issue of flooding, such as a streamlined administrative process, and has pledged to work with a variety of organisations, including the insurance industry.

In a subsequent statement, the Secretary of State for Environment, Food and Rural Affairs gave further details of how the Spending Review settlement will impact on DEFRA's programmes over the next three years. She said:

"The new funds which have been allocated in the Spending Review will ensure that this growth will now accelerate to reach 8.6% a year in real terms over the SR2002 period. The further allocation to the Department of £15 million in 2004/05 and £40 million in 2005/06, together with the amounts available from grants to local authorities and the revenues we expect to be able to raise from new funding mechanisms, will deliver an increase of £150 million in the third year of the Review. This level of resources, together with simplification of the administration of flood defences and effective partnership working with homeowners, local government, the Environment Agency, scientists and the insurance industry will allow us to reduce the risk of threats to life and damage property from flooding."

The funding will be structured as follows:

£ million	2002-03	2003-04	2004-05	2005-06
DEFRA Grants, SCA and Other	114	122	137	162
(Of which Spending Review 2002)	n.a.	0	15	40
ODPM Local Authority SSAs	280	292	332	382
(Of which Spending Review 2002)	n.a.	0	40	90
New funding stream	n.a.	0	0	20
<b>TOTAL</b>	<b>394</b>	<b>414</b>	<b>469</b>	<b>564</b>
<b>Of which SR2002</b>	<b>n.a.</b>	<b>0</b>	<b>55</b>	<b>150</b>

Notes:

DEFRA – Department of the Environment, Food and Rural Affairs

ODPM – Office of the Deputy Prime Minister

SCA – Supplementary Credit Approval\*

SSA – Standard Spending Assessment\*

\*- internal Government accounting procedures

By 2005-06 this spending represents a 43% uplift on the current year, and 72% on the 1999-2000 base year on which the ABI's £145m p.a. call was based.

There is an additional allocation of £55m in 2004/5, only reaching £150m in 2005/6, the third year of the Review. Of that, £40m is from the Treasury, with the remainder being 'raised from new funding mechanisms' and local authorities. In next few years the spend remains below the level that the industry was calling for.

#### **4. After the Deluge....Toxic Mould**

After an event involving water damage there may be a significant amount of work required to repair the property. Any affected areas need to be dried out as fast as possible and treated with an appropriate anti-microbial agent to prevent the growth of mould. Cupboards and other fixtures will be cleaned and carpets and underlay dried out or replaced. However, even if treated in this way, there may still be an unseen mould problem in the wall cavities and other enclosed spaces. Amongst that mould may be *Stachybotrys* and *Fusarium*. It is fungi such as these that have now gained the tag "Toxic Mould".

#### **Toxic Mould: a background**<sup>1</sup>

*And the LORD spake unto Moses and unto Aaron, saying,*

*When ye be come into the land of Canaan, which I give to you for a possession, and I put the plague of leprosy in a house of the land of your possession;*

*and he that owneth the house shall come and tell the priest, saying, It seemeth to me there is as it were a plague in the house:*

*then the priest shall command that they empty the house, before the priest go into it to see the plague, that all that is in the house be not made unclean: and afterward the priest shall go in to see the house:*

*and he shall look on the plague, and, behold, if the plague be in the walls of the house with hollow streaks, greenish or reddish, which in sight are lower than the wall;*

*then the priest shall go out of the house to the door of the house, and shut up the house seven days:*

*and the priest shall come again the seventh day, and shall look: and, behold, if the plague be spread in the walls of the house;*

*then the priest shall command that they take away the stones in which the plague is, and they shall cast them into an unclean place without the city:*

*and he shall cause the house to be scraped within round about, and they shall pour out the dust that they scrape off without the city into an unclean place:*

*and they shall take other stones, and put them in the place of*

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<sup>1</sup> "Guidelines on the assessment and remediation of fungi in indoor environments", New York City Department of Health and Mental Hygiene, January 2002



*those stones; and he shall take other mortar, and shall plaster the house.*

*And if the plague come again, and break out in the house, after that he hath taken away the stones, and after he hath scraped the house, and after it is plastered;*

*then the priest shall come and look, and, behold, if the plague be spread in the house, it is a fretting leprosy in the house: it is unclean.*

*And he shall break down the house, the stones of it, and the timber thereof, and all the mortar of the house; and he shall carry them forth out of the city into an unclean place.*

Clearly, mould has been a recognised problem for centuries. This section looks at the health risks associated with “toxic mould”.

Many species of fungi can pose serious health risks to people. Most documented cases relate to eating contaminated foods, commonly grain products and peanuts and high levels of occupational exposure, mainly amongst agricultural workers.

The health risks associated with “toxic mould” arise from inhalation of mould spores, fragments or metabolites (e.g. mycotoxins). The common symptoms of mould exposure are rhinitis, eye irritation, aggravation of asthma and coughs. The more serious health risks are OTDS (Organic Toxic Dust Syndrome), which is not uniquely caused by mould exposure, and HP (Hypersensitivity Pneumonitis). The former is caused by a single exposure to heavy concentrations of dust contaminated with fungi and produces flu-like symptoms, while the latter may occur after repeated exposure to a substance which provokes an allergic reaction, and can cause permanent lung damage.

As yet, guidelines do not call for compulsory evacuation of an infected site unless the individual is believed to be at risk. Generally, evacuation of young babies and those with suppressed immune systems is recommended.

So far, the “toxic mould” tag has been applied to only a few types of mould. However, many species, including *Penicillium*, *Aspergillus* and *Trichoderma*, can produce mycotoxins which are identical to compounds produced by “toxic mould” and which have been identified as toxic agents.

### Only in America – Muffin and Erin Brockovich

The first Toxic Mould case to hit the headlines was in Dripping Springs, Texas, where Melinda Ballard, insured by Farmers Insurance Group, obtained damages of \$32m. The law suit arose because of her claim that the insurer had not removed water damaged material on a timely basis. Farmers Insurance had spent \$1.4m on remedial work prior to the case.

This was the first case to gain major news coverage, but it was not the first case. A brief history of earlier significant mould related cases, taken from AON Risk Monitor no 8, is given below:

- 1997: In Florida, Martin County won a \$17.4m award against Centex-Rooney Construction Company because of toxic mould damage to a court building that cost \$13m to build. This is considered the landmark case because the court determined that expert testimony linking mould exposure to health problems was admissible in trial.
- 1999: Delaware Superior Court found that a landlord was responsible for tenants' mould-related problems because of failure to maintain the property.
- 2000: In Virginia, a Fairfax County jury found a construction company liable for its decision to use a building material that was susceptible to mould; plaintiffs claimed that the defendant substituted synthetic stucco for real stucco during construction without disclosing the fact.

Since the Ballard case, many thousands of cases have been filed, including other high profile cases. These include a lawsuit filed by Erin Brockovich over mould in her Texan mansion, and one by Ed McMahon. Ed was a former regular on the Johnny Carson show. A water pipe burst in his Coldwater Canyon home. The damage was repaired but, some four months later, McMahon and his wife were suffering from congestion and coughing. To add to this, Ed's pet dog Muffin, who had previously been healthy, died. That's when the mould was discovered. The lawsuit seeks \$20m to cover the damage to the home and the significant mental anguish caused by the loss of Muffin.

### Can it happen here?

The simple answer is 'yes'. The cases in the US have some common themes:

- An initial water damage claim is rectified, usually following what are (or were) considered to be acceptable guidelines, but not all affected areas are thoroughly tested and if necessary treated for mould.
- Mould has been identified and remedial work is carried out to remove the mould. However those carrying out the work do not take the necessary precautions and actually spread the mould in the removal process.
- Purchasers of houses are suing the vendors if they encounter a mould problem.

Some 10,000 cases have been filed in the US over the last three years. These are split as follows:<sup>2</sup>

Defendant profile	No of lawsuits
Insurers for bad faith	5,000
Builders for alleged construction defects	2,000
Homeowners associations for improper maintenance	2,000
Former owners who have sold property	1,000

#### What is the solution?

Two approaches have commonly been taken in the US to try and prevent the small flood of toxic mould claims becoming a large one. The first involves excluding such damage from the insurance contract. In Texas, mould damage is already excluded. However, when it is caused by a risk that is covered, such as a leaky roof, the mould damage is covered. The problem has led to some insurers ceasing to write comprehensive homeowners policies in Texas. The second approach involves limiting the damages payable for mould to an amount such as \$5,000. This is the approach suggested by the Texas Insurance Commissioner.

Regardless of the approach taken to limiting the cost, the best way for insurers to avoid claims in the future is to ensure that water damage claims are treated according to the best practice for eliminating mould.

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<sup>2</sup> AON Risk Bulletin number 8, April 2002

## **5. Storm Modelling**

The working party has begun work to try and address the question: “Given the weather over the last day or days, how many claims do we expect, and where?”

The aim of the research is to build a simple computer model that will predict the number of claims arising from an exceptional weather event, based upon the weather statistics in each location, as measured by the Met Office, and the insurer’s exposure in that area. The intention is to build separate models for the major types of weather event: windstorm, freeze and flood. The pressure of time has meant that the party has only been able to look at storm models in any depth, and even then with somewhat limited success.

The weather data used in the analysis is taken from the ‘Geoproof’ product produced by the Met Office. This contains the following statistics, recorded daily at 652 weather stations around the country:

- minimum/maximum temperature
- rainfall am/pm
- wind speed maximum gust/average
- number of lightning strikes
- snowfall/hailfall

Geoproof includes a table which maps the weather station locations onto postcode sector, which then enables the weather statistics to be matched against the insurer’s exposure and claims data.

### **Building a Storm model**

In principle, a storm model is very simple:

Claim frequency = function(wind strength)

In practice, of course, it is more complicated. The first issue is how to measure ‘wind strength’ in a useable fashion. Then we face the question of whether a single model can be built that adequately describes storm experience as a function of this measure. The potential complications are enormous:

- Different materials and standards of construction in different areas
- Winds in different directions affect different areas in different ways – e.g. structures built to resist prevailing winds will be more vulnerable to storms from other directions
- Storms of different lengths will have different cumulative effects upon buildings
- Wind storms combined with heavy rainfall, for instance (such as the those in October 2000) may be or may appear to be more damaging, if only through the mis-recording of storm and flood claims

## Measuring Wind Strength

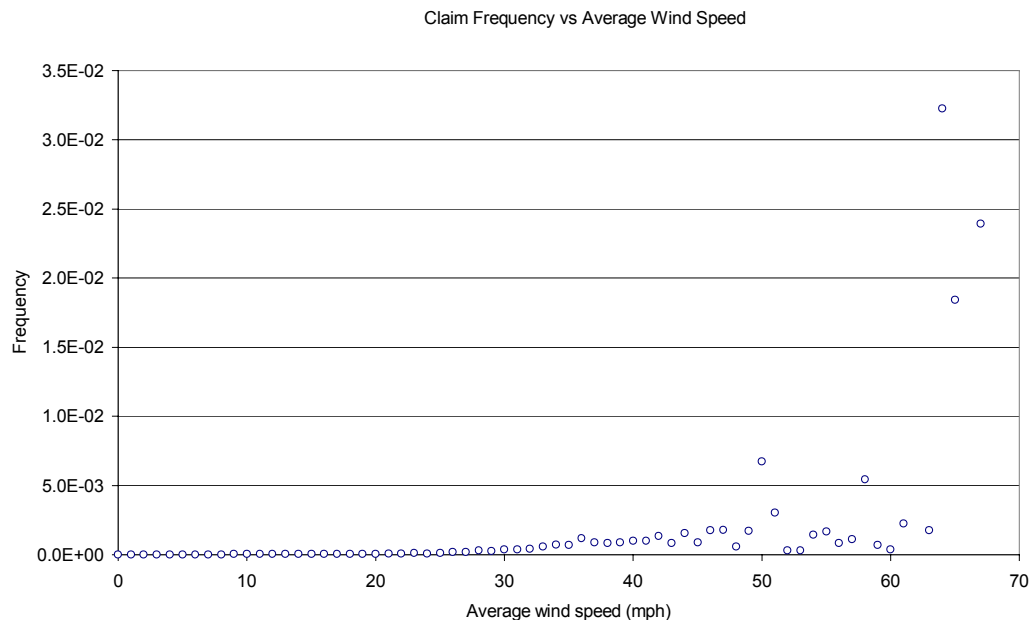
A number of measures of wind speed have been assessed. These are described below.

### Average wind speed

One obvious way to measure wind strength is the average wind speed. The graph shows a scatter plot of the daily frequency of storm claims against average wind speed on the day. The plot is based upon all observed storm claims from 1996 to 2001.

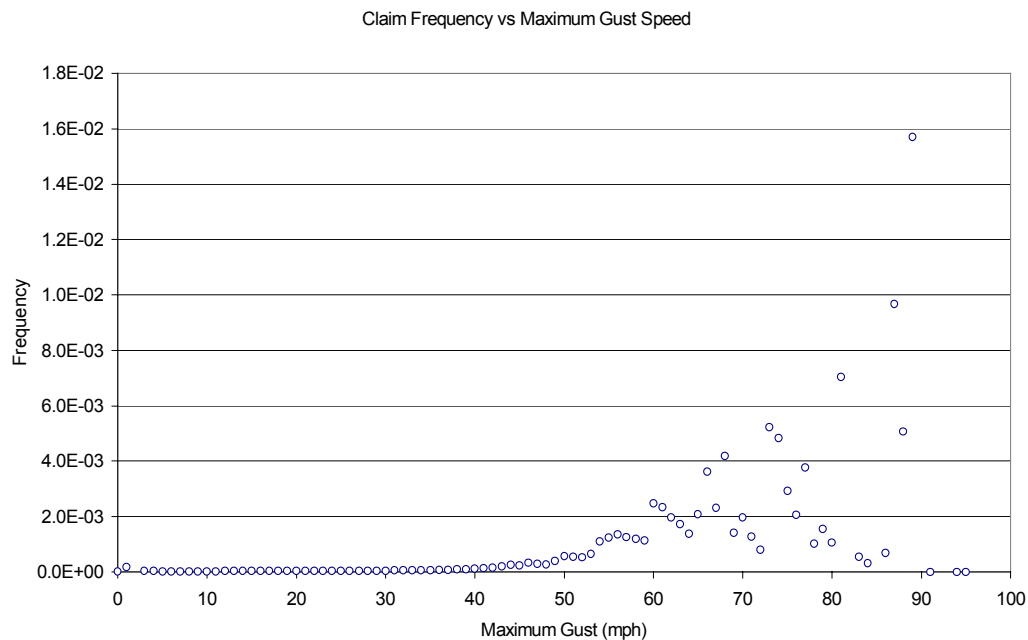
The data is analysed as follows:

We have a number of locations observed over a certain period. We have a policy count (assumed constant throughout the period of analysis) and the observed number of claims on each day in each location. To obtain a point on the graph, we sum, across all cells with a given wind speed (i.e. from all locations across all days), the exposure in those cells and the number of claims in those cells. Dividing the number of claims by the number of policies gives a claim frequency for a given average wind speed.



## Maximum gust

Another obvious measure of wind strength is the maximum gust speed. This would be a good way of predicting whether a structure will snap or break in response to particularly strong gust of wind. Failure caused by a single high load that exceeds the structure's strength is known as fast fracture. The graph below plots the frequency of storm claims against the maximum gust speed on the day; this would be the basis of a model which assumes that all storm claims are caused by fast fracture.

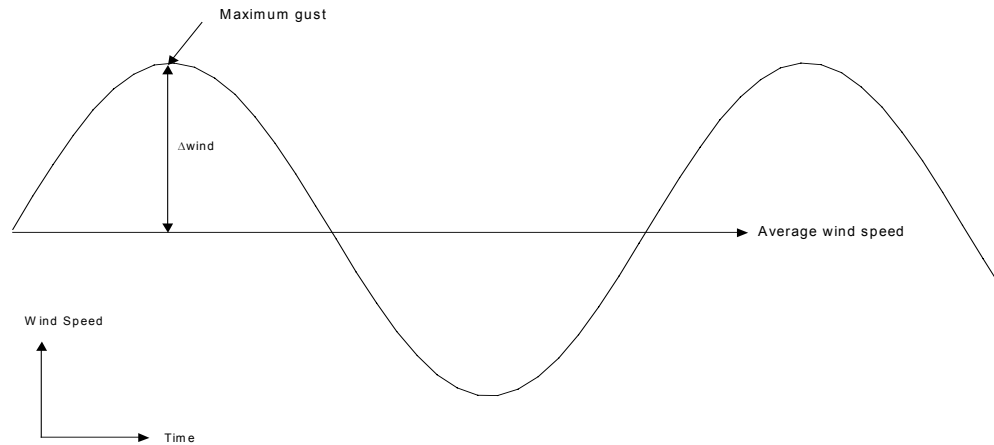


There is clearly more evidence of an increasing trend than with average wind speed. However, there is a strange cluster of low frequency points at high gust speeds which will be discussed later.

## $\Delta$ wind

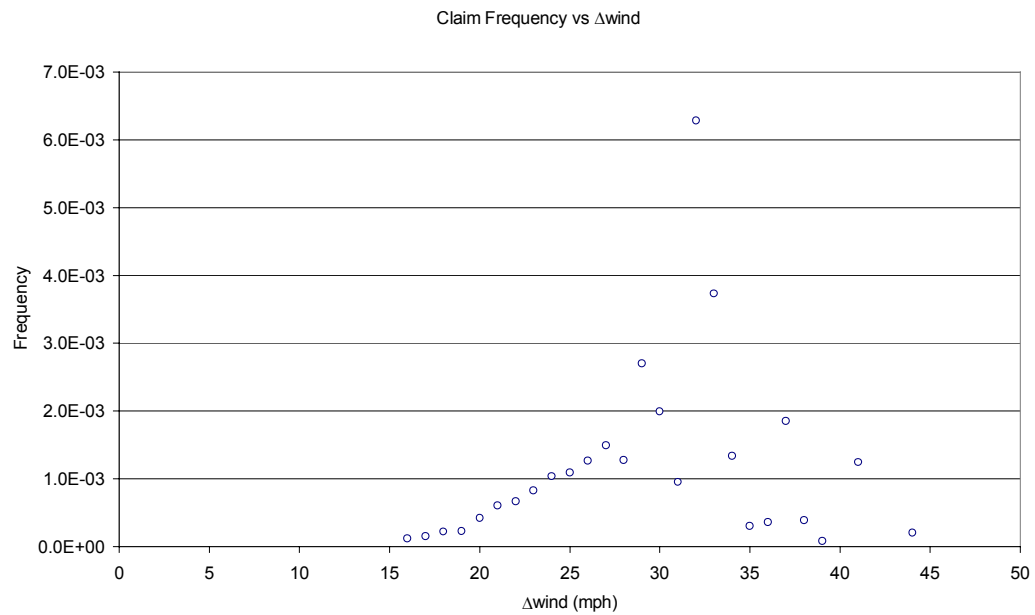
Another simple way of gauging the amount of destruction a storm can cause is to plot frequency against  $\Delta$ wind.

In practice the wind is not of constant strength but a succession of gusts:



$\Delta$ wind is defined as the maximum gust speed in a period minus the average wind speed in the period (i.e. the amplitude of the gusts), and is the key variable in determining the fatigue strength of a structure. Fatigue is the process by which a structure weakens and finally fails under repeated loading well below its initial strength. Of course, a structure will break under fewer load repeats when the repeated loads are relatively high.

$\Delta$ wind is also an important factor in determining the rate at which two rough surfaces (such as roof tiles), which are held in place by friction, become smoothed by repeated rubbing. Eventually the surfaces will have been worn down so much that they slide easily over each at relatively low loads. A plot of claim frequency against  $\Delta$ wind (see overleaf) could therefore be used to develop a model which assumes that all storm claims are caused by fatigue or rubbing damage.

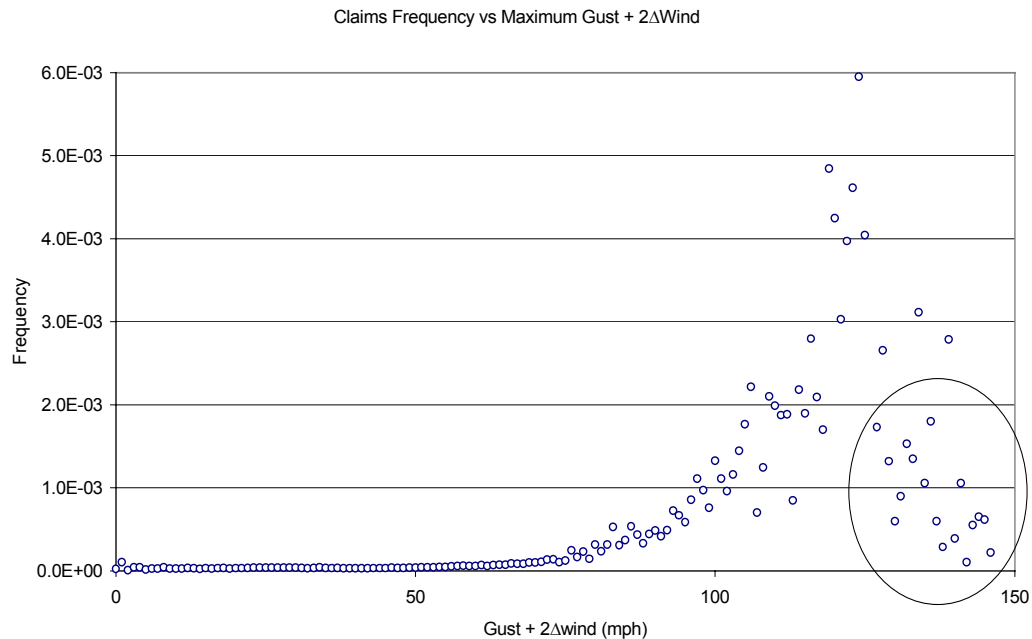


There appears to be a clear and increasing relationship at moderate values of  $\Delta$ wind, but that strange cluster of low frequencies at high values persists. There are fewer points because the range of  $\Delta$ wind is roughly half that of the maximum gust.



### Gust + 2 $\Delta$ wind

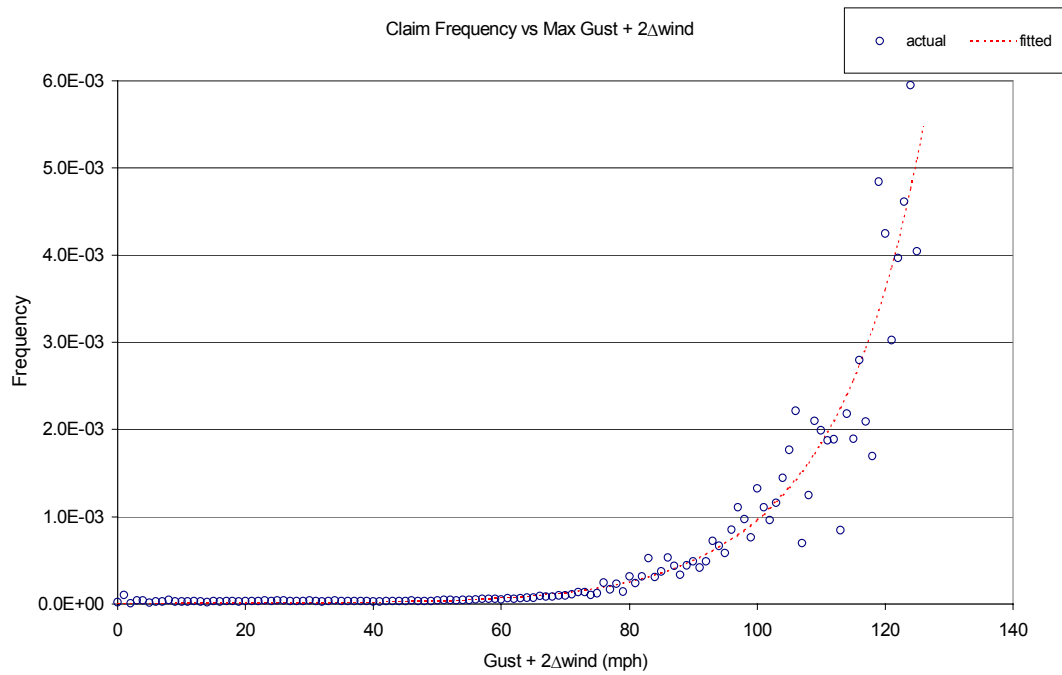
By plotting against a term that is a combination of maximum gust and  $\Delta$ wind we include storm claims caused by fast fracture, fatigue and rubbing damage. Many linear combinations of these terms were investigated and it was found that maximum gust + 2 x  $\Delta$ wind was the best predictor of storm failure. A scatter plot of claim frequency against maximum gust + 2 x  $\Delta$ wind is shown below.



At values of gust + 2 x  $\Delta$ wind above 130 mph, the claim frequencies (those circled on the graph) are still surprisingly low. **Investigation reveals that these claims come from sparsely populated and exposed areas, principally Orkney and the Shetland Islands.**

This raises the interesting point, already mentioned, that different regions, with different conditions and building traditions, may need different models. The shape of the frequency plot for Orkney and the Shetlands is completely different from the overall graph; there are virtually no claims at moderate to high wind strengths and then relatively few at very high wind speeds.

It is worth remembering at this point the motivation for this analysis: to allocate claims resource to deal with the floods (no pun intended) of claims following a severe weather event. The Orkneys and Shetland Isles will never give rise to large numbers of claims simply because the population is so low; we are much more interested in densely populated areas. In fitting a model to the data we have therefore decided to exclude these postcodes. The graph overleaf shows the data excluding these postcodes and the model that has been fitted.



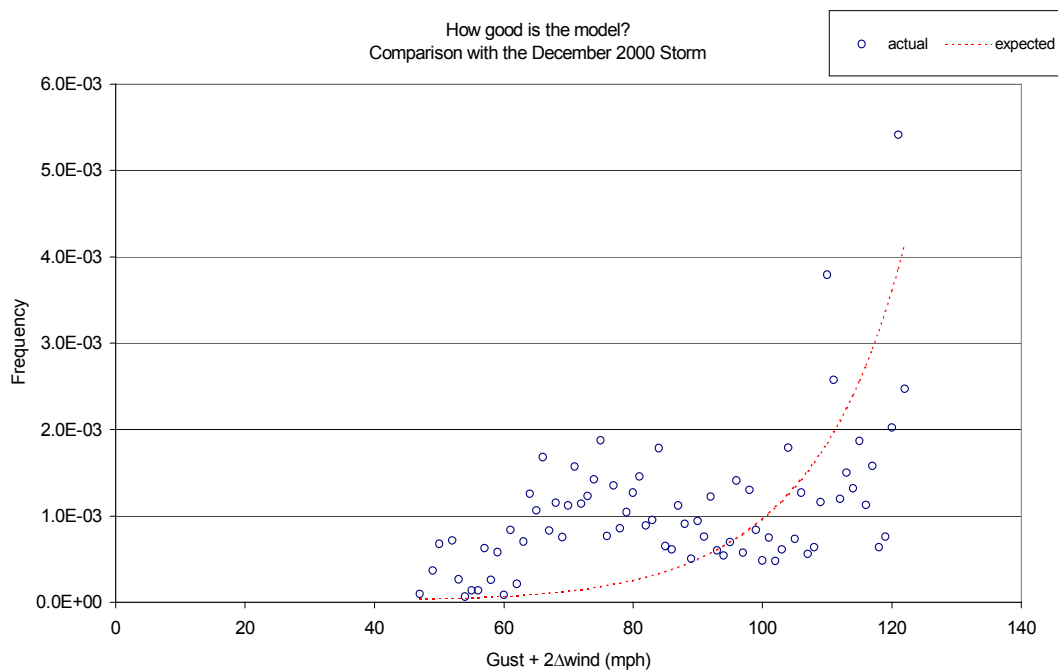
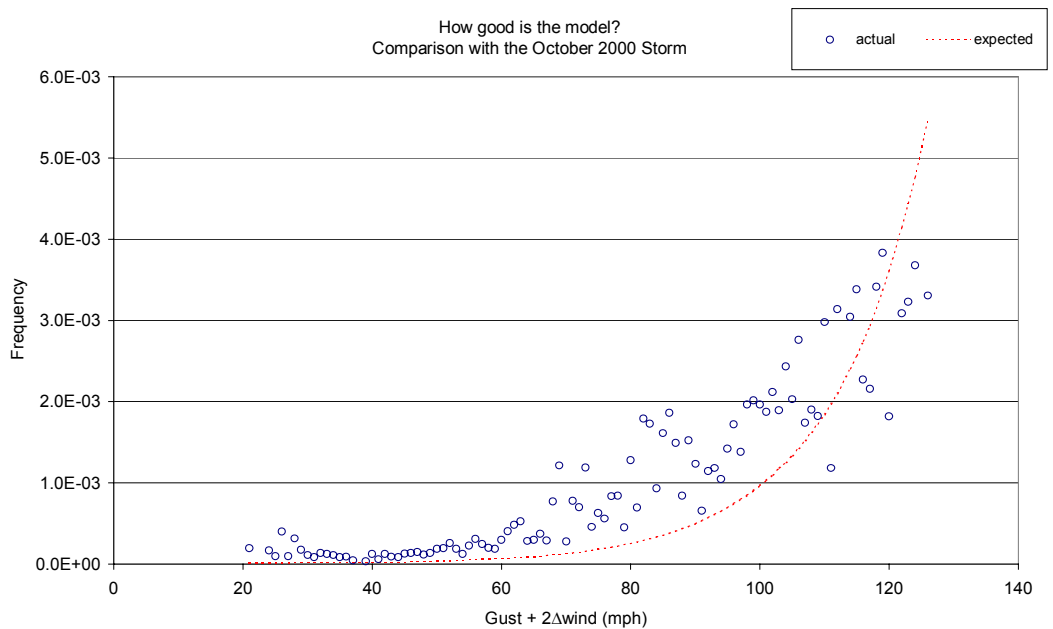
With suitably doctored data there is a clear relationship between wind strength and claim frequency. The fitted model (shown by the dotted line on the graph) is a generalised additive model of the form

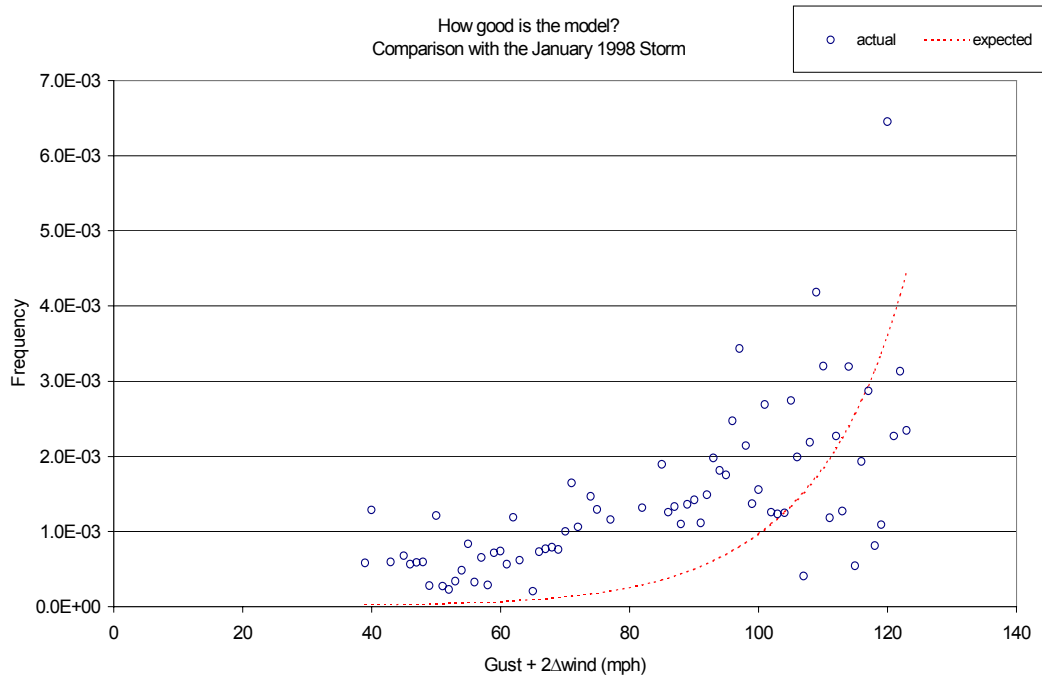
$$Y = \exp[f(x)],$$

where  $f$  is a cubic smoothing spline. A Poisson error structure has been used and the data has been weighted by the exposure attaching to each observation.

### How good is the model?

The model has been tested against three severe storm events within the period over which the model has been fitted. The first graph compares frequencies of storm claims with occurrence dates between 29th – 31st October 2000 with the fitted curve; the second shows frequencies from storms on the 12th and 13th December 2000, and the third compares storm frequencies on the 3rd – 5th January 1998 with the fitted curve.





Although the model is a good fit to the overall data set, it sadly appears to be a dreadful predictor of the claims experience resulting from particular events! This seems a bit odd and is under investigation.

One possible explanation is that the wind events giving rise to a particular observation of maximum gust + 2 x  $\Delta$ wind are not unique; there is an infinite variety of combinations of maximum gust and  $\Delta$ wind which give rise to a single observation. A better fit may be obtained by a model of the form

Claim frequency =  $f(\text{maximum gust}) + g(\Delta\text{wind})$ .

Research is continuing and an update will be provided at the conference.