Crichton, D. 2008, Flood Management in Japan and Britain. A comparison.

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The following statements reflect my personal views.

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Abstract

The wording of the EU Flood Directive was agreed on 25 April 2007. The Directive will require EU member states to adopt sustainable flood management practices. Such methods were introduced in Japan in 2001 and the paper compares progress with such practices in Japan and Britain.
There are many similarities between Japan and Britain, not only is the geography and climate similar, in both countries the government refuses to pay compensation to flood survivors, which means that a strong private insurance industry has developed for flood cover. Since 2001, the Japanese have changed from a policy of building structural flood defences to one of sustainable flood management, and this requires the participation of the insurance industry to provide market incentives to avoid further floodplain construction. However the Japanese insurance industry suffers from a lack of sufficient data to enable selective underwriting and is keen to learn from insurers in the UK.

Key words: Flood Directive, insurance, sustainable flood management, climate change.

Explanatory Note:
Great Britain is a collection of over 400 islands off the coast of the continent of Europe. Japan is a collection of 3,900 islands off the coast of the continent of Asia. Both have maritime climates, but Japan is also exposed to spring snowmelt floods, summer tropical cyclones and tsunamis. As well as having more severe rainfall events, Japan has a 10,000 foot high mountain range down the centre of a long and narrow island chain which means short, steep rivers which quickly bring floods to the densely populated low lying urban areas.

Britain has about half the population of Japan and is about two thirds the size of Japan in area. Despite its size, until recently the UK was the fourth largest economy in the world (now overtaken by China). It is important to understand that Britain is made up of the two kingdoms of England and Scotland together with the Principality of Wales. 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 local administration district 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 Orkney and Shetland Islands, while within Scotland politically, have their own fundamentally different legal system and language, and a measure of local autonomy[1]. Since devolution in April 1999, Scotland has had its own elected Parliament, which has legislative powers over internal affairs. Recent public opinion polls show a majority of the population in Scotland favour independence from England.

Wales has its own language, established church and elected Assembly, but this has limited legislative powers so in terms of legal and political organisation is similar to England. For some of the issues considered in this paper, it is necessary to distinguish between England, Wales, and Scotland, because the approaches are significantly and increasingly different, especially with regard to local authority matters such as land use planning and building standards.

[1] Crichton, D., 2005 "The Shetland Islands" Island Vulnerabilities web site available from http://www.islandvulnerability.org/ShetlandCrichton.pdf

The United Kingdom consists of Great Britain, 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.

Introduction

The EU Flood Directive has now been agreed and has been formally adopted[2]. Among its provisions is the requirement to adopt sustainable flood management practices. Japan provides an excellent example of a shift in policy to what is called "sustainable flood management" in Europe. While Europe is still experimenting with sustainable flood management[3], particularly in Scotland[4] with demonstration projects in the River Devon, River Tweed and with the "SAFER" project, Japan introduced the "Human adjustment to floods" concept in 2000, based on Gilbert White's work in the 1940s. The basic idea is to adjust the way humans live with floods by land use zoning, flood proof buildings, and flood insurance. The role of flood insurance is important in that it provides direct economic incentives to individuals to relocate or take their own precautions against flood while at the same time facilitating rapid economic recovery after a flood. Kuniyoshi Takeuchi of Yamanashi University has described[5] the change as being a shift "from rivers to basins" and some of the information about Japan in the following paper is based on Prof. Takeuchi's excellent work.

Structural versus natural flood management

Structural flood management involves the construction of walls, tunnels and reservoirs, whereas natural methods involve the creation or restoration of natural flood storage areas using agricultural practices and forestry. The biggest problem with structural solutions is that they do not always work, whether through lack of funding or lack of data. In the USA, research[6] has found:
Much of the baseline information, on which current determinations of the height of the 1 percent flood (and all other floods) are made, is out of date, and data collected about flood events are inadequate to support analysis of loss reduction strategies. *Baseline hydrology technical reports have not been updated, and stream gauging data collection has been reduced. Levee designs and flood risk determinations may not reflect current conditions and as a result could increase the risk to those behind levees and in floodplains.*

This is reflected in the UK as well, except that too often some of the crucial information, such as changes to the catchment upstream are just not taken into account at all. A classic example of this was the floods in Carlisle in January 2005 where a 180 year return period event produced an apparent 1,000 year return period flood, because the hydrology had not taken into account dramatic changes in land management upstream with the introduction of field drains, flood banks and removal of trees.

There are other problems:

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[2] DIRECTIVE 2007/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2007 on the assessment and management of flood risks**.** Official Journal of the European Union, L288/27. Published on 6 November 2007.

[3] Fleming, G., 2001. **Learning to Live with Rivers.* Final Report of the Institution of Civil Engineers' Presidential Commission to Review the Technical Aspects of Flood Risk Management in England and Wales", Institution of Civil Engineers, London.

[4] Werritty, A., August 2006. "*Sustainable flood management: oxymoron or new paradigm?"* **Area** (2006) 38.1, 16–23

[5] Takeuchi, K., 2002. "Flood Management in Japan- From Rivers to Basins" Water International Vol 27, 1. Pp 119- 131. Illinois, USA

[6] Gerald E. Galloway, Gregory B. Baecher, Douglas Plasencia, Kevin G. Coulton, Jerry Louthain, Mohamed Bagha and Antonio R. Levy, 2006. *"Evaluation of the National Flood Insurance Program: Assessing the Adequacy of the National Flood Insurance Program's 1 Percent Flood Standard"* Water Policy Collaborative, University of Maryland for FEMA. Released for publication, May 2007.
This report was one of 13 prepared for FEMA on the National Flood Insurance Program and its components. All of the reports are available for download at:
http://www.fema.gov/business/nfip/nfipeval.shtm

1. They can give a false sense of security as demonstrated in the New Orleans floods of 2005. An unofficial comment from a US engineer was *"There are two types of levees. Those that have failed and those that will fail."*
2. Flood defences can themselves be damaged by floods. The Japanese government calculated that after the Naka River and Kokubu River floods of 1998 and the Fukuoka floods of 1999 that half of the costs of the floods consisted of repairing damage to the flood defences themselves[7].
3. Structural flood defences need constant maintenance. The more the defences, the greater the cost of maintenance, taking much needed public spending away from schools and hospitals and other essential services.
4. If a river is walled in and not allowed to flood onto the banks, it is more likely to deposit sediment in the bed of the river. This raises the height of the river, meaning that the walls have to be raised too.
5. Defences can simply displace the problem upstream or downstream. This is a particular problem in continental Europe where one country's flood management solution is another country's increased problem.
6. When a flood defence fails, the results can be more catastrophic than if the defence had not been built at all because the failure can be sudden and more people may be in the danger zone. People may be less likely to respond to evacuation orders when there are flood defences[8].
7. Flood walls can act as a barrier to stop the flood draining back into the river or sea. After the 1953 coastal flood for example, many defences had to be demolished to let the water drain away.
8. Flood walls will have to be repeatedly raised as climate change impacts are felt.

There is still a place for structural solutions to defend existing urban areas, or essential infrastructure. For example, there is much to be said for combining flood defences in the design of river crossings which can also be used for generating tidal energy. A tidal barrage across the River Severn for example could provide 5% of Britain's energy needs. If this proceeds, insurers will need to take the opportunity to ensure that the design also reduces the flood risk in the Severn corridor.

Japanese flood management policy

Flood defence standards are very high in Japan. Like the Netherlands, the Japanese use 0.01 percent (10,000-year) minimum standard of service for coastal works and 0.5 percent (200-year) to 0.05 percent (2,000-year) protection for river systems. By contrast, England uses a 0.1 percent (1,000) year standard only for the centre of London, a 200 year standard for coastal risks, a 100 year standard for fluvial risks and a 30 year standard for surface water drainage. In practice, the standard of protection is very variable for example the £100m Jubilee River scheme in London only offers 60 year return period protection. Scotland has a minimum standard of service for flood management schemes of 100 years plus climate change to 2050.

Japan introduced their new policy "Effective Flood Management, including Basin Responses" in January 2001. Under the new policy, flood measures were passed from the Ministry of Construction to the Ministry of Land, Infrastructure and Transport. The policy changed from confining rivers within dykes and dams to managing floods within the river basin as a whole. The previous "no floods" policy for inhabited areas was proving to be very expensive and not completely effective. It was changed to a policy of allowing some floods but with measures to reduce their severity through land use planning and more resilient construction. The discussions at that time were limited to departments directly involved in flood control and it was not until recently that central government, in particular the Japanese Cabinet Office,[9] started to examine flood control seriously.

Some policymakers in Japan have recognised that a new way of thinking on the part of civil engineers and planners is needed, because "softer", more human and ecological solutions are more sustainable

[7] Takeuchi, K., 2002. *"Flood Management in Japan- From Rivers to Basins*" Water International Vol 27, 1. Pp 119- 131. Illinois, USA.
[8] Pfister, N.. 2002. *"Community response to flood warnings: the case of an evacuation from Grafton, March 2001*." EMA The Australian Journal of Emergency Management, vol 17, no 2, pp19-29. Mt Macedon, Victoria, Australia. ISSN: 1324 1540.
[9] Personal communication with Ms Kana Takahashi of the Nomura Research Institute, Tokyo, November 2006

than concrete. It is perhaps particularly significant that Japan is considering this approach, given that not only has the country been subject to some very severe river floods often caused by typhoon rainfall, it has high urban densities, and in addition is very sensitive to the risk of landslides and tsunami. All of these are good reasons why one might expect the country to be more attracted to structural defences. In many ways, Japan is a world leader in its expertise on such defences. At Tsukuba Science City near Tokyo they have sophisticated physical models of catchments and flood control systems, including a huge "rain room" which can mimic any form of rainstorm.

So far however, the idea of linking flood protection programmes and land use planning for basins is currently not progressing. There is a new law called "law for water disaster prevention", but this does not seem to reflect sustainable flood management principles.

The emphasis of current countermeasures for flood in Japan is on
1) providing information on evacuation,
2) creating flood hazard maps (local governments are making maps marking the highest water level of past flood disasters, which are publicised by them) with a view to enhancing the population's awareness, and
3) measurements and reconstruction policies following flood disasters.

Japan suffered high death tolls from floods during the period 1945-1959, with more than 1,000 people killed every year and two of the floods each killing more than 5,000 people. The worst event was the Isewan Typhoon flood in 1959 which killed 6,000.

Their policy of building structural defences during 1960 to 2000 resulted in a reduced death toll, but economic losses continued to be high, because the amount of flood plain development was increasing as urbanisation spread, often in flat areas previously used as paddy fields, encouraged by the perception of safety from the existence of the new structural defences. The severity of the problem is indicated by the fact that annual economic losses have fluctuated between 0.1% and 10% of national income since 1880. Investment in flood defences since 1960 has been at around 1% of national income (compared to current investment in England at around 0.3% of national income). Even during wartime, flood investment in Japan was running at 0.35% of national income, whereas in England, flood defence investment did not really start in a big way until after the 1953 storm.

By 1990, when flood investment was costing four times as much as annual economic losses from flood, it was realised that economic losses were still happening and that more than 50% of flood damage was from damage to river control works themselves. Tax payers started to ask questions about the high levels of costs which benefited only those in flood hazard areas, especially as much of these costs were incurred in repairing the flood defences.

The concern was brought to a head with the Naka River and Kokubu River floods of 1998 and the Fukuoka floods of 1999. The flood discharge in the Naka River reached 2,700 cumecs[10] following 1,254mm of typhoon rainfall, and 25 were killed. (The biggest ever recorded river discharge in the UK[11] was 2,268 cumecs in the River Tay in 1993.) The Kokubo river floods damaged 23,000 homes. In 1999, despite large flood defences, even downtown Tokyo was flooded and one person was killed.

The 2000 strategy was based on zoning of the river basin as follows:
<u>Area I: Forested mountains, with sparse habitation</u>.
Use for flood storage. (Similar to the policies only now being developed by the Forestry Commission in Scotland, or the experimental Ripon scheme on the North Yorkshire moors)

<u>Area II.1: Sparsely populated floodplain</u>
Instead of walls and dykes along the river bank, build walls around the communities, and use land raising or flood resilient construction using special building codes. Control development with land use planning.

<u>Area II.2: Populated floodplain where floods can extend widely over many villages.</u>

[10] Cubic metres per second
[11] Black A R and Anderson J L (1994) *The great Tay flood of January 1993*, 1993 Yearbook, Hydrological Data UK series, pp. 29-34, Institute of Hydrology, Wallingford.

Continuous levee systems can be used on a selective basis, but supplemented by land use planning and more resilient building codes.

Area III: Urban areas
Emphasis is on

- The management of sewage and drainage systems with pumps and storm water storage.
- Flood proofing of emergency and infrastructure facilities especially underground shopping and transport.
- Robust warning systems.
- Dissemination of hazard maps.
- Dissemination of location of evacuation routes and shelters.
- Storage of emergency food and drinking water supplies.
- Temporary measures such as sandbags and demountables stored ready for use.

However, full risk assessments to define such zones are not being undertaken as yet.

Flood Insurance in Japan

At just under 60%, there is not such a high penetration of flood insurance for domestic properties in Japan[12], as in Britain. Flood cover is bundled in with fire cover, but earthquake cover is optional. As in the UK, there is no government compensation scheme for flood survivors. For businesses, the market penetration is much lower. There is no private earthquake insurance for businesses, but there is a government earthquake reinsurance scheme.

Premiums for flood insurance used to be set by an association which took data from insurers, similar to the old UK "tariff" system. However in 2000, the industry was liberalised and insurers could charge whatever premium they wished. At present differential rates are still not being applied by insurers and in particular, the rates do not differ from region to region due to a lack of underwriting information:

In particular:

- Meteorological data only goes back 70 years
- There is no precise long term flood data.
- Government is reluctant to release river gauging data.
- There is a lack of high resolution topographic data for flood mapping.

Flood Insurance in the UK

The changes in Japan have echoes of the UK insurance position after the abolition of the UK insurance tariff system in the 1960s. Lack of information about flood risk, combined with the fact that total flood losses were a relatively small part of household insurance claims costs (around 4%), meant that there was no incentive on insurers to apply differential rates depending on flood risks.

However in the UK a number of factors conspired to encourage insurers to apply differential flood rates:

1. A period of severe flood events, starting in 1990, produced large insurance losses, mainly from fluvial floods.
2. The increasing use of computerised geographic information systems by insurers, at first for marketing purposes, but increasingly for underwriting and exposure management, has made it possible for insurers to map flood risks at a high resolution, down to individual address level.
3. The publication of government agency flood maps which showed not only historical flood events but also for the first time, modelled flood probabilities[13].
4. Demographic and social changes meant that people were living longer and there were more single occupancy households and more immigration. This all meant a high demand for new houses especially in the low lying south east of England. Many of these new houses were and still are being built in flood hazard areas.
5. Flood defence spending has not kept pace with the new house building in hazardous areas.
6. Climate change holds out the prospect of more frequent and more severe flood events in the future (see Appendix 4).

[12] Information in this section is based on an interview with Ms Kana Takahashi of the Nomura Research Institute, Tokyo in November 2006.

[13] Morris, D G and Flavin, R W (1996) *Flood risk map for England and Wales*, Report No.130, Institute of Hydrology, Wallingford

7. The very competitive insurance market in the UK has kept average premiums low for many years (see table) so it is no longer possible to "subsidise" people living in flood hazard areas.

Table: average annual insurance premiums for household insurance in the UK
Source: Association of British Insurers.

	Buildings	Contents	Buildings and Contents
2000/2001	£168	£144	£291
2001/2002	£171	£146	£287
2002/2003	£173	£149	£294
2003/2004	£188	£159	£321

Average premiums have not kept pace with increases in the value of contents or rebuilding costs, let alone increases in the frequency and severity of flood claims. There are a number of reasons for this:

1. More business is handled by "direct" insurers without the use of brokers or other intermediaries, thus saving commission costs
2. More business is written on the internet, thus saving on administration expenses.
3. Insurance systems have become more efficient due to computerisation and economies of scale as insurance companies merge.
4. Investment income has increased in recent years: insurers invest premium and are getting higher returns.
5. Claims handling has become more efficient with more authority delegated to specialist claims handling companies who are under considerable pressure to keep costs low.
6. Insurers are increasingly reluctant to offer cover in flood hazard areas, and where they do it is often only for existing business and subject to very large excesses or deductibles. Some newer direct writing companies have set out an explicit policy of refusing to quote for any risk in a flood hazard area.

In Japan, the Government has now produced hazard maps which show the maximum flood risk, but there is not enough resolution to calculate probabilities or to show individual properties. The Japanese government is researching the type of data needed by insurers and is currently seeking information about insurance approaches in Europe. It seems likely that it will only be a matter of time before Japanese insurers take a much more selective approach to the pricing of flood risks as competition builds up.

UK Flood Management Policy and Insurance

The UK has much to learn from the Japanese experience on flood management, but is at least debating the issues[14]. While UK floods are generally less severe than in Japan, the geography, topography and climate are similar in many ways and climate change and growing urbanisation are raising the same sort of problems. UK Government refusal to compensate flood survivors means a high demand for private insurance and a strong insurance industry in the UK. UK insurance has been liberalised for longer than in Japan and strong competition combined with a high market penetration has meant heavy investment by UK insurers in flood mapping, modelling and data collection.

Following Devolution of legislative powers to Scotland in 1999, a number of significant differences are arising between Scotland and England. Thirty of these have been set out in Appendix 5.

Insurers assess risk based on the three sides of the "Crichton Risk Triangle" (see Appendix 6)

Hazard; the frequency and severity of the weather or seismic event
Exposure; the value and location of lives and property exposed to the event
Vulnerability; the extent to which lives, livelihoods and property are affected by the event.

Each side of the triangle needs to be addressed.

Flood **Hazard**

[14] Howarth, W., 2004 "A Small Island Getting Smaller? A review of *Making Space for Water.*" The Journal of *Water Law*, **15** 2004 6 pp242-248. ISSN 1478-5277.

Can be reduced by structural or non structural measures. Some work is going on in Scotland on sustainable flood management funded by the EU and by WWF, but UK Government has a policy of refusing to fund any such measures. This may change if Scotland becomes independent from the UK as seems increasingly likely because the Scottish Parliament is strongly in favour of sustainable flood management methods.

Structural flood defences have been seriously under funded and rationed in England for years. The budget in England was reduced in 2006 by £15m at a time when the insurance industry was asking for an increase[15] of £200m. England and Wales annual spend is £413m which equates to £131 per house at risk of flood. Spending is effectively "rationed" in that benefits need to be six times costs to have any chance of a grant.

Scotland's current budget is £89m which equates to £556 per building at risk of flood. Benefits only need to exceed costs for a scheme to qualify for 80% grant aid. At present the Scottish budget has £20m unallocated, waiting for draft schemes to be submitted. No scheme has been rejected in Scotland on the grounds of lack of money; the budget is simply increased as required. Scotland has a target of defending all properties against the 100 year flood by 2008, but this is unlikely to be achieved without using sustainable flood management methods.
The Association of British Insurers (ABI) has privately expressed satisfaction with progress in Scotland and is mainly concerned about the lack of flood defences in England[16].

Climate change projections indicate that the flood hazard will increase significantly in the UK due to

- Faster rainfall run off during summer drought conditions
- Concentration of rainfall into more severe events
- Rising sea levels
- Construction of new reservoirs for water supply or renewable energy
- Requirements of the Water Framework Directive which inhibits the modification or maintenance of rivers or lakes to cope with changes in rainfall patterns.

For example, in one case study in England (the detailed location must remain confidential) a farmer recently cleared vegetation from a 400 year old culvert to reduce flooding in his fields and in the interests of good husbandry. As a consequence the next time there was heavy rain, sheltered accommodation for old people downstream was badly flooded and the watercourse came within an inch of flooding an airport runway. Was the farmer correct to clear the vegetation? Should he be prosecuted under the legislation introduced to transpose the Water Framework Directive?

Exposure
Exposure to hazards can be reduced by land use planning to discourage development in hazardous areas. There are no effective controls on flood plain development in England. Indeed central government impose targets on local government which give them no choice but to allow floodplain development. 11% of all new houses built since 2000 have been in the flood plain[17].

By contrast, since Devolution in 1999, both Scotland and Wales have introduced strict controls on land use management and in Scotland most local authorities consult with the insurance industry on land use strategies using "Flood Liaison and Advice Groups" (FLAGs) which follow the insurance template (see Appendix 2).

FLAGs have now been established throughout Scotland and give an opportunity for regular informal face to face meetings. The meetings include:

Local government specialist senior staff

- Planning officers

[15] ABI, November 2006. "Coastal Flood Risk – Thinking for tomorrow, acting today." ABI. Available from http://www.abi.org.uk/DISPLAY/default.asp?Menu_ID=773&Menu_All=1,773,0&Child_ID=651
[16] ABI, July 2006. "A Future for the Floodplains" ABI, London. Available from http://www.abi.org.uk/Newsreleases/viewNewsRelease.asp?nrid=13291
[17] House of Commons Communities and Local Government Committee November 2006. *"Planning Gain Supplement"*. The Stationery Office, London HC 1024.
Available from http://www.publications.parliament.uk/pa/cm/cmcomloc.htm

- Building Control officers
- Emergency Planning officers

Plus representatives from

- Insurance industry
- Water authority
- Scottish Environment Protection Agency
- Ecology interests such as Scottish Natural Heritage or WWF
- Property developers
- Land owners

And sometimes representatives from the railways or canal authorities as appropriate.
On occasion, there have been other interests represented such as archaeologists or river restoration or hydrology specialists who provide useful advice and information.

The combined expertise of members of FLAGS is also useful for other projects such as steering groups for some research projects, such as the EU SAFER project[18], or the publication of an award winning drainage impact assessment guide[19], or suggesting the best methods of flood protection in particular circumstances. Sometimes the best method may be compulsory purchase and demolition, but there is no funding for this in the UK as yet.

The meetings discuss

- Land use planning
- Sustainable flood management and maintenance
- Sustainable drainage
- Flood protection schemes and strategies
- Flood warning schemes
- Registers of vulnerable people (disabled, elderly, single parents)
- Latest relevant research or government policy
- Insurance problems
- Civil contingencies and emergency planning
- EU Water Framework Directive issues
- Concerns over local issues such as dam safety etc.

It is an opportunity to encourage "joined up thinking" on matters such as integrating sewage management, storm water drainage and flood management, as was done very effectively with the River Tay flood prevention scheme. This has helped to avoid situations in Scotland like the Japanese Kashimadai Town flood in 1986 which was made worse by drainage problems, but done on an informal basis without resort to the courts. The Carlisle floods in England on the other hand (see appendix) were characterised by considerable sewage contamination.

Unfortunately because it is informal, it is not possible to insist that all the relevant organisations are present, or even that a FLAG is held at all. In particular, property developers are often absent (though invited) and this can lead to decisions being made without their input, but this simply reduces pressure to build on the flood plain.

Vulnerability

Where hazard and exposure exist, the risk can still be reduced by early warning systems, exercise drills, evacuation shelters, resilient communications, transport, and power supplies, high rise buildings with no ground floor occupancy, and temporary demountable defence systems.

Early warning systems are still at an early stage of development in the UK and public awareness is very low. Members of the public are often reluctant to register for an early warning scheme because they think it may make it more difficult to get insurance. Insurers are reluctant to use their call centres to warn policyholders in case the warnings turn out to be false alarms. As the Grafton case study shows (see appendix) it can be difficult to persuade people to evacuate, and as the Carlisle case study shows, often people do not want to leave their property due to a fear of looting.

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[18] SAFER Strategies and Actions for Flood Emergency Risk Management. See www.eu-safer.de

[19] North East Scotland Flood Appraisal Group, 2002 *"Drainage Impact Assessment: Guidance for Developers and Regulators."* Aberdeenshire Council, Stonehaven

Government in England has made no efforts to implement more resilient building codes, although they have been introduced in Scotland. Resilient reinstatement after a flood is only offered by a few insurers; indeed, reinstatement is often to a less resilient standard than before the flood in order to save money. For example in Carlisle, solid pitch pine doors and skirting boards were thrown away rather than being allowed to dry out, and were replaced by hollow doors made from chipboard and fibre board. Pitch pine is unavailable nowadays and there is anecdotal evidence of discarded doors and skirting boards being removed from rubbish skips, dried out and sold at huge profits. Sensible standards[20] for resilient reinstatement have been drawn up, but do not seem to be used by insurers.
Local government in Scotland has been experimenting with temporary demountable defences but there is no national strategy or funding for these. There is only one comprehensive review[21] of the different types available.

Civil contingency plans

Civil contingencies legislation in the UK has imposed duties on local authorities to draw up comprehensive plans for disasters and to assist householders and businesses in their areas. However, in England, little seems to have done to ensure emergency control rooms, hospitals, shelters, and emergency service vehicles and equipment are located in safe areas and there is no additional central government funding for this. In England, more than two thousand hospitals are located in the floodplain.
Contingency plans for mass evacuation by rail exist for London, but are not well developed elsewhere.
Government has issued strong legislation requiring action by local government but without adequate funding, local government does not have the resources to fulfil its new duties. A major flood event was simulated in 2004 called "Exercise Triton" which tested flood response and command and control arrangements at a local, regional, and national level, along with the interaction between England and the Welsh Assembly Government.
The report on the exercise[22] concluded that: *"the UK simply does not currently have the capability to respond to a major flood event."*

Damage evaluation
In the UK there are two distinct types of damage evaluation:

Economic costs
The methodology is specified by government and tables produced based on data from a very small sample which relates only to England.

Financial costs
This is based on the actual amounts paid out in claims by insurance companies using a huge database of floods from all over Britain which has been collected since 1993 from the 25 biggest insurance companies (see Appendix 3). It is now the biggest flood losses database in the world and has been privately funded by different insurance companies in turn. It is currently funded by the Royal Bank of Scotland. The data is analysed by 28 different variables and is held at the University of Dundee[23].

Financial costs are roughly 2.5 times bigger than economic costs on average. Economic costs are used for benefit- cost analyses for flood defence grant aid. In England government grant aid is usually only

[20] Garvin, S., Reid, J., Scott, M., Building Research Establishment, East Kilbride, Scotland. 2005 *"Standards for the repair of buildings following flooding"* Manual C623. 133pp. Construction Industry Research and Information Association (CIRIA), London.
[21] Crichton, D. 2004. *"Temporary local flood protection in the United Kingdom. - An independent assessment."* A Benfield Hazard Research Centre technical report. Free download from: http://www.benfieldhrc.org/activities/misc_papers/Temporary_local_flood_protection.pdf
[22] Hayden, P, November 2006. *"Management of major flood events: Fire and Rescue Services contribution to the emergency phase; report for the Chief Fire Officers Association Board*." Chief Fire Officers Association, UK.
[23] Black, A., Werritty, A., and Paine, J., October 2006. *"Financial costs of property damages due to flooding; the Halifax Dundee Flood Loss Tables 2005*." University of Dundee, sponsored by Halifax General Insurance Services.

available where the economic benefit is at least six times the construction cost. In Scotland, the economic benefit must simply exceed the construction cost.

Flood insurance Penetration

As in Japan, the UK Government never pays compensation to flood survivors. It is left to private insurers. While the numbers of owner-occupiers with private contents insurance is growing (from 89% in 1995 to 93% in 2004), only 39% of tenants in the social rented sector[24] in England and Wales had contents insurance in 2004. Three million low income households are uninsured for contents.

In Scotland, 57% of social tenants have flood insurance and in 2005 the Scottish Government spent £500,000 on promoting private insurance in this sector in Scotland.

Unfortunately, social housing is often located in flood hazard areas where the land is relatively cheap. The result is that society is forcing the most vulnerable people and the most essential workers to live in hazardous locations, and they are often uninsured.

Modelling

UK insurers now use sophisticated modelling and mapping techniques. Flood risk areas have been mapped by private insurers using airborne synthetic aperture radar interferometry at a cost of £5m. The results have been donated to government and published on the internet for free access in an effort to discourage flood plain development. Airborne LiDAR has been used in some urban areas to obtain higher resolution.

The design of buildings is an important aspect of vulnerability as is the contents mix which varies depending on socio economic group. Data from credit referencing agencies is therefore an important component.

[24] The social rental sector consists of homes owned by public bodies or housing associations which are then rented out to low income families, based on their need or on their value to the community. For example essential workers such as police, nurses, teachers, etc, may well receive priority treatment along with the elderly, disabled, or single parent families.

Conclusions

Sustainable flood management for most countries is little more than a set of ideas and experiments. The Japanese approach is important because the ideas are beginning to be implemented now, and the Japanese insurance industry is being encouraged by its government to take a more selective approach to underwriting as a key part of its sustainable flood management policy. This provides a unique opportunity to obtain baseline data and monitor trends over the coming years.

If society is to learn from new techniques of flood risk management, it needs to conduct more research into comparisons between different countries, rather than trying to reinvent methods which may already have been used elsewhere.

Kelman[25] suggests that such a comparison could use indicators and standards, and involve conducting surveys, extracting themes and looking at policies and outcomes. He also suggests that similar principles might be applied to non-flood hazards too or different types of flood hazards.

In the meantime, the UK could learn a great deal from the Japanese approach to flood management. The intention to mix structural and non structural defences to suit the circumstances is admirable, even if not yet fully implemented and the strategy confirms the importance of land use planning and resilient construction supported by insurance as a tool to provide economic incentives as part of a package of measures to adapt to flood risks.

There are many similarities between Japan and the UK and while Japan has to deal with more severe flood risks, there is a growing body of experience around the world which shows that sustainable flood management techniques can be used even in highly populated areas. Once Japanese insurers have caught up with the use of more selective underwriting approaches based on differential flood hazards, they will be able to apply market forces to encourage such techniques.

Climate change and sea level rise means that flood risks are growing substantially especially in island communities like the UK and Japan. Japanese solutions deserve close scrutiny by UK government. On the other hand, the Japanese insurance industry could learn from the work of UK insurers in assessing and selectively pricing flood risks.

[25] Dr Ilan Kelman, University of Colorado, Boulder, USA. Personal communication 21st December 2006.

Appendix 1

Selected Case studies

Grafton[26], New South Wales, Australia. March 2001

There seems to be a widespread belief in the UK that flood warnings should be delayed until the authorities are absolutely sure that the flood will come, in case people panic unnecessarily. This fascinating and well documented case study shows that, at least in Australia, far from panicking, the problem is trying to persuade people to take any action until they actually see the water coming. There is no reason to believe that the British are any different when it comes to flood warnings, but the writer is not aware of any British cases which have been so thoroughly researched as this one.

In March 2001, a large low pressure system passed over New South Wales, bringing torrential rain. The Bureau of Meteorology issued a flood warning that predicted the Clarence River would rise to 8.1m or more at Grafton. As the city's levees were designed to give protection to 8.23m there was a very real danger they would be overtopped, flooding most of the urban area.

It was decided to advise the evacuation of 12,000 residents. However less than 10% of residents left the city during the nine hours the evacuation was in effect.

In the event, the evacuation was not necessary, but the water came within 0.2m of the top of the levee. A detailed follow up in the two to three weeks after this event was carried out to find out why the residents had ignored the evacuation orders.

191 questionnaires were completed in a random telephone survey of residents of Grafton, of these, 90% live in flood prone areas. Only 22 respondents (13%) actually had evacuated to a safe area. A further 47 (29%) would have evacuated if their doors had been knocked, or were waiting until the last minute. 97% were aware that an evacuation warning had been issued, mainly from the radio or from friends or neighbours, employers or pub landlords.

The conclusion of the researchers was that since the construction of the levee, the residents had experienced few direct effects of flooding and were less conscious of the flood threat, so less likely to act. Most had never considered the possibility of one day having to evacuate. Many discussed the situation with others, especially older people who said things like the "water never gets up to here". Pubs were well patronised, giving others the impression that everything was normal. In particular, many visited a pub next to the river to see the water for themselves. Many were reluctant to evacuate because of the need to care for their pets.

Perth 15th January 1993

The 1993 River Tay floods have already been mentioned in the paper. The River Tay is the longest river in the UK with the biggest catchment and heaviest flows. It becomes tidal as it passes through the town of Perth in Scotland. In 1993 over 1,200 properties, mainly in Perth, were flooded. There are some particularly interesting aspects:

Before the event

In the days leading up to the event there was considerable snow fall in the River Tay catchment. Great foresight was shown in the form of the cooperation of the owners of the large hydro electric schemes upstream of the Tay, as the reservoir water levels were allowed to fall in order to provide capacity for the inevitable snowmelt, otherwise things could have been even worse[27].

Following the event

Insurers continued to provide flood cover to former clients, but naturally they adjusted their premium levels and deductibles. A key factor in this was the intentions of the public authorities regarding flood defences. Perth was fortunate, in that it was the first major flood in Scotland for many years, and attracted great sympathy and political support for new defences. As a result, a new flood protection scheme was commissioned and completed in 2001. The scheme was designed to provide protection against the equivalent of the 1993 and 1814 flood events combined with an extreme 100 year tide plus a freeboard of

[26] Pfister, N.. 2002. *"Community response to flood warnings: the case of an evacuation from Grafton, March 2001*." EMA The Australian Journal of Emergency Management, vol 17, no 2, pp19-29. Mt Macedon, Victoria, Australia. ISSN: 1324 1540

[27] McInally, G A, Anderson, J L and Lee, D.,1995. "*Positive operation of hydro-electric schemes to aid flood control: experiences in the Tay catchment*." In: Reservoirs in River Basin Development. Eds – Santbergen & Van Westen. Balkema, Rotterdam, The Netherlands.

0.3 to 0.4m. The cost of the 1993 flood was £30m and the defences cost £26.5m. The scheme includes the use of natural stone cladding appropriate to the area, architectural features at gate locations, shallow slope embankments integrated with the surrounding landscape, a riverside path with views of the river, an informal cycle route, enlarged golf course at North Inch, improvement works on football pitches, retention of mature trees, planting of shrubs, raising of pavements to retain views of the river etc[28]. A number of local artists were commissioned to produce sculptures which were built into the defences.

However, these magnificent defences did not solve all the problems.

In 2002, wet weather in the spring filled holding tanks designed to delay peak flows. Unfortunately, a severe thunderstorm latched on to the town in July, and the ensuing cloudburst could not be contained. Localised flooding ensued, exacerbated by the flood walls. For the first time in its 100-year history, the two-day Perth Agricultural Show had to be cancelled and the central park was closed to visitors for the entire summer due to health fears from sewage. The Show had a lucky escape in 2004, when just after it ended, torrential rain fell for three days from a decaying hurricane, causing the cancellation of the Perth Highland Games for the second time in three years.

The floods of 1993, 2002 and 2004 were in line with climate change predictions: 1993 was a prolonged wet winter period with rapid thawing of snow. 2002 and 2004 were due to violent summer thunderstorms. In the 2002 and 2004 floods, the public perhaps did not fully appreciate that the parks used for the Agricultural Show and Highland Show were designated as sacrificial flood storage areas as part of the flood prevention scheme. The cancellation of these two shows was a small price to pay for saving widespread flooding of the homes and businesses in the city.

Elgin[29] 15th November 2002

Elgin is the county town for Moray, which lies to the West of Aberdeenshire and was once part of Grampian Region in Scotland. Moray is perhaps best known for RAF Lossiemouth and the many excellent malt whisky distilleries in the area. The River Lossie has a documented history of flooding dating back 250 years. Twenty flood events have been recorded since 1750, with 10 floods in the last 50 years. Most recently Elgin has flooded in 1997, 2000 and 2002.

Severe flooding occurred in Elgin in July 1997 and November 2002. During both events extreme rainfall fell for over 48 hours on the upper part of the catchment on already saturated ground. Normal flow in the River Lossie is approximately 5 cumecs[30]. During the 1997 and 2002 events the flow reached 122 cumecs and 140 cumecs respectively.

The 1997 event is estimated to have a return period of 1 in 40 years. The event inundated approximately 600 residential and 170 commercial properties. The 2002 event is estimated to have a return period of 1 in 60 years. In this instance more than 650 residential and 180 commercial properties were inundated. Typical flood depths during the two events ranged between 0.15m and 1.0m.

Number of properties at risk from flooding in Elgin

Return period (years)	Residential	Commercial	Total
1 in 5	135	10	145
1 in 10	340	45	380
1 in 25	405	135	540
1 in 50	690	185	870
1 in 100	765	235	1000
1 in 200	865	275	1135

An interesting feature of the history of Moray flooding is the seasonality of floods in the last 50 years. Between 1956 and 1997, there were eight flood events, all occurring in July or August and due to summer thunderstorms. In each case the synoptic conditions were virtually identical and involved an airstream

[28] Clive Bowman, Perth and Kinross Council, 2003. *"Perth Flood Defence Scheme*" Journal of the Perthshire Society of Natural Science, Vol. XVII, 2003. pp8 – 26. ISBN 0 9513261 3 9. Danscot Print, Perth, Scotland.

[29] This section uses information from Crichton, 2004. *"Flood risks in the former Grampian Region since Devolution"* WWF Scotland.

[30] Cubic metres per second

from the North being blocked over Moray by a Westerly air stream causing continuous rain for two or more days.
July or August floods
• 1956 (twice)
• 1957
• 1958
• 1970
• 1978
• 1982
• 1997
However the most recent floods have occurred at different times of the year:
• April 2000
• November 2002
It is interesting to speculate on why floods are starting to happen at different times of the year. There is no reason to suppose that summer floods will not continue at the same frequency as before, but if autumn and spring floods are now starting to happen as well, is this the start of a future trend? If so, the frequency of future flooding could be much greater. It should also be noted that summer floods tend to cost insurers half as much as floods at other times of the year, because the warm weather helps to dry out properties. If there are to be more autumn floods they will be much more expensive.

Another explanation for the autumn and spring floods of course is the extent of new building which has taken place on the floodplain since 1967. Focus groups conducted in Elgin in 2006 revealed public concern about this, and described how construction is still going on, for example several residents mentioned the construction of a home for disabled children on marsh land in the floodplain. This may be a classic example of deliberately exposing vulnerable people to a known hazard.

The council has been talking about the need for flood defences since the 1997 floods, but are only looking at structural solutions. Nine years on, they have still not finalised plans or submitted them to the Scottish Executive for approval and grant aid. Meantime building work has continued in flood hazard areas, but this is mainly for social housing, especially for the elderly as private buyers can no longer obtain insurance or mortgages in such areas. The current plans contain no sustainable flood management features and consist largely of high walls through the centre of Elgin, a historic cathedral city. They are estimated to cost £157m. This would protect 1,000 properties against the 100 year flood, at an average cost of £157,000 per property. The average value of a property in the flood plain is estimated at less than £50,000 as the area is currently blighted by regular flooding.

Carlisle, 8th January 2005
Carlisle is a large town in the North of England near the "Lake District". 4,500 homes, schools, and businesses in Carlisle were flooded[31] and 10,000 people were made homeless either by flooding or by power cuts. In Warwick Road alone, 500 homes had to be evacuated by boat or helicopter.
"Carlisle storms and associated flooding" (http://www.ukresilience.info/carlislesummary.pdf) is a multi-agency debrief report that considers the events of January 2005 that affected electricity supply and emergency responses for 6000 residents,
The floods followed two months rain in 24 hours, a 180 year return period event. At Shap, 227mm (9 inches) of water fell in 72 hours. All the water falling on the north Lakes and northern Pennines has to pass through Carlisle. These rivers used to flood onto agricultural land upstream which reduced the peak flow, but farmers have been constructing flood banks and field drains to keep the water from their fields for many years. There are three rivers in Carlisle, the Eden, Caldew and the Petteril, all flowing into the Solway Firth. Peak flows coincided with high tide in the Firth. Water levels in some places rose about 4 feet in an hour. Houses were up to six feet deep in water contaminated with sewage and oil and in some parts of the city the water was 15 feet deep.
Electricity supplies, telephones and mobile phones all failed to work, even the police radios as transmitter batteries failed. For all except those with battery radios there was a total communication blackout. The local BBC radio station was praised by all as the only source of information. The main police and fire stations were located in one of the lowest parts of the floodplain and had to be abandoned at an early stage in the flooding. Security alarms stopped working as batteries drained and many residents reported

[31] Robertson, D., 2005. *"The Great Flood: Cumbria 2005*" 168pp. Hayloft Publishing Ltd, Cumbria. Ca17 4DJ. ISBN 1 904524 28 1.

staying in their cold, dark, flooded homes or businesses for several nights to discourage looters. Two elderly ladies refused to be evacuated because of fears of looting and died from the cold.

It was not just the flooding: there were also severe winds. The storm was described as a "weather bomb" by the Met Office. A wind speed of 128mph was recorded causing damage to houses as well as widespread power cuts. More than half a million trees across the county were blown down, and flooding occurred in many parts of the Lake District as well as Carlisle. 90% of schools in the county were closed because of flooding, storm damage, or lack of electricity.
The main surface water drainage and sewage in Carlisle converged on a single manhole, but according to one flood survivor, who has researched the matter, there was only one outflow pipe from this manhole and it led into the river. During the event the outlet was sealed by a flap valve as the river rose leading to backup into the manhole and sewage overflow into housing and businesses. Anecdotal evidence indicates that the first sign of flooding and much of the early damage was this sewage overflow which happened before the rivers burst their banks.

Boscastle, 16th August 2004

Boscastle is a picturesque small village on the south west coast of England which attracts many tourists. It is repeatedly flooded, with significant floods in 1827, 1882, 1894, 1903 (twice), 1926, 1932, 1958 and 2004. The 1827 event was the most severe in terms of flood depth, and the 1958 event caused at least one death. Despite this record, the 2004 event seemed to take the authorities by surprise with the Environment Agency quoted as saying it was a 500 year return period event.
Shortly after the 2004 event a book[32] was produced by local journalist David Rowe, about this most recent flooding. This lavishly illustrated book provides a very good record of the experiences of the people involved in the Boscastle floods. It contains a section on the cause of the floods, contributed by the author of this paper. Based on many interviews with eye witnesses and rescuers, it was written in aid of the North Cornwall Flood Appeal, and is full of extremely moving stories of individual heroism and examples of community spirit.
Although the event was relatively small compared with historic flood events in this location, it happened when the village was full of tourists and it received much publicity partly due to the presence of a TV film crew who were shooting a documentary series in the village at the time and the visual excitement of a fleet of helicopters carrying out daring rooftop rescues in front of the cameras. In this way, the public gained the perception that this was an unusually severe flood. This flood was not only predictable but, given the history, inevitable. However, it is only now that flood defences are being planned, perhaps because of the publicity the event received.
In the 2004 event, heavy rain was caused by the remnants of Hurricane Alex, which had picked up vast amounts of water from the Atlantic on its way towards the UK, and dropped it over the hills behind the village. The layout of the buildings and absence of any effective flood protection measures meant that the water was channelled into the centre of the village.
No lives were lost directly from the 2004 event, largely because the village lies in close proximity to no fewer than three helicopter rescue stations and seven rescue helicopters were on hand within 20 minutes to rescue inhabitants from rooftops. Many of the spectacular rescues were broadcast on TV around the world. The trauma of the event may have contributed to the subsequent premature deaths of some elderly residents.
The 2004 Boscastle flood cost insurers between £10m and £15m. The ABI subsequently asked the local MP, Paul Tyler, for information about any complaints relating to claims handling, but not a single complaint was received. Nevertheless, clean up and rebuilding was still going on a year after the flood event.

The 2004 event contains a number of lessons to be learned:

- It was pouring with rain and many people went to the Long Bar of the Wellington Hotel. Few were aware that this 400 year old hotel is built on top of a culvert containing the River Jordan near its confluence with the Valency. The owner and a former employee did know and checked the culvert. They decided to evacuate the crowded bar and the rooms upstairs, but people were not keen to go out into the rain. Meanwhile the back wall of the bar had become a dam, and the water was rising fast. Minutes after the hotel was evacuated, thousands of tons of water came through the first floor windows at the back and suddenly filled the bar area with mud and water 4 metres deep. Many could have lost their lives.

[32] Rowe, D. November 2004. *"Boscastle 16 August 2004 – the day of the flood"* 64pp Truran Books Ltd, Truro, Cornwall. ISBN 1 85022 193 6

- The village was full of tourists, and some 50 cars floated away in the current, not only that, witnesses spoke of a strong smell of petrol from the waterlogged cars, so there would have been a fire risk.
- There were some mini skips used for collecting bottles, clothing etc for recycling. These floated away and could have caused serious damage. A giant oven from the bakery also floated away, smashing through the walls of the shop.
- One resident remembered the 1958 flood and when she saw the river rising she evacuated people from her shop, deployed flood boards and sandbags and went to higher ground in good time. Her shop which was 300 years old, crumbled and was completely washed away. If she had not acted so quickly, many could have drowned. On the other hand if she had simply allowed the flood water to pass through her shop as it had in 1958, it may not have been destroyed.
- Three months later, many villagers still suffered from nightmares.

Climate change is causing a greater incidence of severe short duration localised flash floods in both winter (Carlisle, January 2005) and summer (River Rye, N. Yorkshire, June 2005) caused by convection storms which can generate massive amounts of rainfall in a short period. Such floods are often difficult to predict from flood maps and can happen almost anywhere, even on hills (Llandudno, June 1993)

River Rye Floods, Sunday, 19th June 2005

This was a sudden localised flash flood which mainly affected Thirsk (30 miles North of York) and the villages of Helmsley, Hawnby, Fangdale, Boltby, Thirlby, Sutton-under-Whitestonecliffe, and surrounding areas in North Yorkshire. Around 40 houses were flooded in Helmsley alone and two helicopters had to winch people to safety. It was caused by a localised thunderstorm which produced hailstones the size of a £1 coin and a month's worth of rain in a few hours. The lightning could be seen from Scarborough, 30 miles away. The flooding happened quite suddenly on a Sunday evening, with cars being washed away in some cases and a bridge badly damaged. One farmer lost more than 250 sheep and a campsite beside the river was suddenly covered by fast flowing water. 24 hours earlier the campsite was occupied by more than 10,000 people (one camper claims 25,000 people) many of whom, according to the landlord of the local pub, had been drinking heavily after attending a motorcycle rally. Such people would have been very vulnerable as the fast flowing river engulfed the site. Five marshals involved in clearing litter from the site on the Sunday evening were washed downstream but later rescued from trees. If the flood had happened just 12 hours earlier when the campers were still sleeping the possible consequences could have been disastrous.

While it is easy to be wise after the event, this flood raises the whole issue of the safety of campers who often use flat land next to rivers for camping. In Wales and Scotland there are special guidelines for local authorities to use as conditions of licensing camp sites in flood hazard areas to ensure that precautions are taken.

Boltby reservoir was constructed in 1880 near Thirsk. It has a 20m high earth embankment. At the time of the River Rye floods in Yorkshire on 19th June 2005 the embankment and spillway suffered extensive damage from overflow discharge. As a result it was decided to discontinue the reservoir rather than repair it. Work was carried out to lower the overflow level by 8m by cutting a "slot" in the embankment and to construct a new overflow channel. This was completed in March 2007 and the works take the reservoir outside the scope of the Reservoirs Act 1975.

Dolgarrog, North Wales, 2nd November, 1925

On Monday, 2nd November, 1925, there was a blow out of the lower section of a portion of the Eigiau dam in the Conwy valley in North Wales[33]. The water scoured a channel 70 feet wide and 10 feet deep, as 50 million cubic feet of water surged down to the Coedty reservoir below. Coedty reservoir was nearly full at the time and the spillway had to cope with a surplus discharge well in excess of its designed capacity. The dam was overtopped, washing away the embankment, and the core collapsed. There was an almost instant release of 70 million gallons of water. A wall of water, mud, rock and concrete hit the village of Dolgarrog at 9.15pm. Fortunately many of the villagers were attending a film show at the village Assembly Hall out of the path of the flood, and 200 workers were working late in the nearby aluminium factory, otherwise more lives would have been lost. As it was, ten adults and six children were killed and

[33] Thomas, D., W., 1997 "Hydro Electricity in North West Wales" National Power plc, Llanrwst, Wales.

many houses were destroyed. At the subsequent inquest, the deputy coroner said that *"as Dolgarrog had a floating population … it was impossible to estimate the extent of the catastrophe in regard to human life".* A rather unfortunate turn of phrase, especially as one body was not found until ten months later, having been carried away down the River Conwy. Huge boulders, the size of houses, can still be seen in the village.
It later transpired that the general manager and board of directors of the company which owned the dams knew that there were defects in them from the beginning, but chose to keep the facts secret. No one was ever held to account, and two of the streets in the rebuilt village were named after directors of the company[34].
Again this case is an example of a flood which could have had even more serious loss of life if it had happened at a slightly different time. Just two or three hours later most of the villagers would have been in bed in the danger zone.

Dumfries, 1st December 2006.
This is an example of an area which is flooded so frequently that the property owners in the area have adapted to such an extent that flood defences are no longer required.
The Whitesands area in the centre of the town of Dumfries was flooded on 1st December 2006. This was the 64th time this area has been flooded in 16 years and was caused by the River Nith overflowing following 1.5 inches of rain in 12 hours.

The Dumfries and Galloway FLAG has considered the Whitesands problem in detail and taken insurance advice from the author. There is no easy solution to the River Nith floods due to the topography and ecological factors. However, it could be argued that because the area floods so often, the adaptation measures already taken may be sufficient and only limited investment in defences is required such as a low wall to prevent small "nuisance" floods and the supply of temporary demountable defences. These cannot defend against floods deeper than one metre, but such floods are relatively infrequent.
Most of the area is now used only for car parking and bus stops. It is a business area and no one lives on the ground floor. The main businesses are the tourist information centre which is raised up a flight of steps and the local branch of a major bank. The ground floor of the bank is entirely empty and unused, all transactions and plant are on the first floor which is accessed from high ground at the side and rear of the building, and business can proceed as normal during a flood event.
The flood water is clean and of short duration so can be easily cleared up and only a small area is affected. The main shopping area in Dumfries is on high ground.

Milnathort, 14th December 2006.
In 2006, Scotland had the worst protracted rainfall since 1938. On 14th December 2006, there was flooding in Milnathort, near Kinross, when much of the town had to be evacuated despite the recent completion only four months before of a new flood defence scheme costing £500,000 in which the river had been "walled in" as it passed through the town. Press reports said that flood survivors were "enraged" at the failure of the scheme which they had assumed would give them protection.

It is interesting that for some reason the council commissioned these new defences without reference to their FLAG or to the Scottish Environment Protection Agency and they were built by a civil engineer in the traditional way, with walls on each bank of the river without any attempt at attenuating the flow through sustainable flood management techniques. The river overtopped its banks upstream of the defences and water came through the town and could not escape back into the river. Arguably if the council had consulted experts in the FLAG, or had used natural flood management methods this flood might not have happened.

[34] Draper, C., 2002 "Walks in the Conwy Valley" Gwasg Carreg Gwalch, Llanrwst.

Appendix 2: List of Flood Liaison and Advice Groups in Scotland (Source: Crichton)

1. Almond River (West Lothian, Edinburgh City)
2. Angus
3. Argyll and Bute (coastline longer than France)
4. Ayrshire (South, East, and North Ayrshire Councils)
5. Cart River and Lower Clyde (Glasgow City and Renfrewshire)
6. Clackmannan
7. Clyde Catchment (East Dunbartonshire, East Renfrewshire, Glasgow City, Inverclyde, North Lanarkshire, Renfrewshire, South Lanarkshire, West Dunbartonshire.)
8. Dumfries and Galloway "DAGFLAG"
9. Dundee, City of
10. Edinburgh, City of
11. Falkirk
12. Fife
13. Highland
14. Kelvin River and Forth/Clyde Canal. (N. Lanarkshire, E. Dunbartonshire, Glasgow City)
15. North East Scotland "NESFLAG" (Aberdeenshire and Aberdeen City)
16. Perth and Kinross
17. Scottish Borders
18. Shetland Islands
19. Stirling

Country	% of existing properties at risk	% of new build in flood hazard areas
England (100 year flood)	**9** (Source: ABI)	**11** (Source: DCLG Select Ctte.)
Wales (100 year flood)	**12** (Source: Welsh Assembly)	**negligible** (since 2004)
Scotland **(200 year flood)**	**3.8** (Source: Scottish Government)	**negligible** (since 1995)

The "Insurance Template". All Scottish local authorities with FLAGs have adopted some or all of these standards for several years.

Residential standards required if insurance is to be offered at normal terms are as follows:

Type of housing	Standard of protection	
	Return period	**Annual probability**
Sheltered housing, and homes for the disabled and elderly	1,000 year	0.10 per cent
Children's homes, boarding schools, hotels, hostels	750 year	0.15 per cent
Basements used for accommodation	750 year	0.15 per cent
Bungalows without escape skylights	500 year	0.20 per cent
Ground floor flats	500 year	0.20 per cent
"Flashy" catchments (little or no flood warning available)	500 year	0.20 per cent
Bungalows with escape skylights	300 year	0.33 per cent
Caravans for seasonal occupancy only, provided adequate warning notices and evacuation systems are in place	50 year	2.00 per cent
All other residential property	200 year	0.50 per cent

In each case up to the year 2050, taking climate change into account.

Climate Change

This adjustment should reflect the possibility that the 100 year return period flood now will, by 2050, become:

- 10 to 20 year for coastal flood (ignoring increasing wave heights)
- 60 to 65 year for fluvial flood

Source:
Scottish Executive Central Research Unit Report, May 2001

Appendix 3: National Flood Insurance Claims Database (The "Dundee Tables")

Details of thousands of British flood insurance claims since 1993.
Produced by Dundee University with assistance from:

- ABI
- Allianz
- AON (previous sponsor)
- AXA
- CILA
- CIS Co-op.
- Congregational and General
- Cunningham Lindsay
- Direct Line (current sponsor)
- esure
- GAB Robbins
- Halifax General Insurance (previous sponsor)
- Liverpool Victoria
- Lloyds TSB
- NFU Mutual
- NMA Insurance
- Norwich Union Group (previous sponsor)
- Salvation Army General Insurance
- Zurich Financial Services (UKISA) Ltd

Can be used for

- Premium setting
- Reinsurance requirements
- Claims validation
- Benchmarking
- Valuation of benefits of flood defences.
- Training
- Modelling
- Cost of under insurance
- Monitoring claims inflation
- Identifying causes of damage for improving building standards.
- Identifying fraud.

Appendix 4: Foresight Project Predictions of annual average costs (insured plus uninsured) of UK flooding by 2080 (£billion at 2004 prices)

Scenario	Drainage floods	River + coastal	Total	(% of GDP)
World Markets (High Growth)	15	27	42	0.19
Global Sustainability:	3.9	7	10.9	0.08
National Enterprise:	10	20	30	0.41
Local Stewardship (Risk Management)	1.5	4	5.5	0.08
Current average	0.3	1.0	1.3	0.2

Policy in England is very much looking for high economic growth even at the expense of increased flooding costs, in other words the World Markets scenario. Ignoring the human factors, this can make some sense. High economic growth can compensate for loss of property along the way. Under the World Markets scenario, flood damage costs would still only represent 0.2% of GDP. (The floods of summer 2007 in England cost the equivalent of 0.3% of the GDP at that time). Scotland seems to take more account of the human factors and may be on track for the Local Stewardship scenario, but the much lower flood damages with Local Stewardship still represent 0.08% of GDP, due to lower economic growth, and remember these are UK figures. Society needs to decide whether the human factors are more important than growth.

The insured cost of the two events in 2007 totalled more than double the current average insured and uninsured cost of £1.3 bn shown above. This highlights the fact that flood damage occurs in concentrated bursts, geographically and in time. Flood events would be concentrated in high risk areas and would vary from year to year. We could be looking at huge costs in some areas, with considerable human costs and long term economic decline. For insurers, it would raise issues of solvency, and challenge claims-handling systems, particularly if they cannot be standardised and rationalised as designed in the FASTER system.

In fact, in 2008, the Pitt Review revisited the Foresight predictions, and judged that the position is likely to be worse. " ..the latest work on climate change shows a small but plausible risk of much greater sea-level rise." , and " we may have to cater for bigger increases in river flows than we have envisaged to date."

In all scenarios, Foresight research shows that some places are particularly exposed, especially around major estuaries. For example the Firth of Forth has one of the biggest oil refineries and one of the biggest coal fired power stations in Europe at risk of flood, as well as a main food distribution hub and thousands of homes. None of these are adequately defended against flood.

Source:

Evans, E., Ashley, R., Hall, J., Penning-Rowsell, E., Saul, A., Sayers, P., Thorne, C. and Watkinson, A. 2004. *"Foresight. Future Flooding. Scientific Summary: Volume I Future risks and their drivers*." Office of Science and Technology, London.

Evans, E., Simm, J., Thorne, C., Arnell, N., Ashley, R., Hess, T., Lane,S., Morris, J., Nicholls, R., Penning-Rowsell, E., Reynard, N., Saul, A.,Tapsell, S., Watkinson, A., Wheater, H. 2008 *An update of the Foresight Future Flooding 2004 qualitative risk analysis*. Cabinet Office, London.

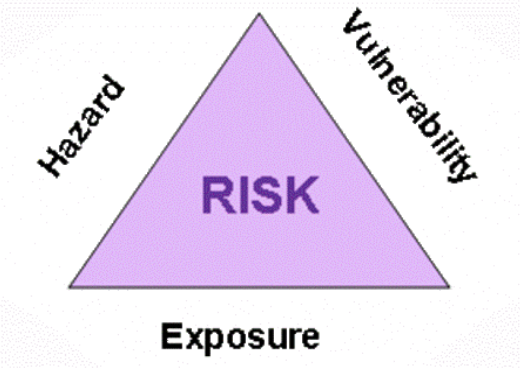
Appendix 5: Summary of some differences between Scotland and England regarding flood risk.

		Scotland	England	
1	Planning Policy	No building in floodplain (follows insurance template)	Floodplain building allowed under "sequential rule". Average 11% of all new buildings have been in the floodplain since 2000. 12% of schools and hospitals are at risk.	
2	Direct involvement of local communities and local knowledge.	Flood Liaison and Advice Groups (FLAGs) cover 94% of Scottish population. FLAGs enable planners to have dialogue with key stakeholders and adjoining local authorities.	No system for planners to consult with insurers or other key stakeholders other than the EA.	
3	Planners can be sued for allowing floodplain development	Yes, under Hedley Byrne v Heller (1963)	No, following Ryeford Homes v Sevenoaks District Council (1990)	
4	Flood maps	River, estuary and coastal flood, modelled and historic including combined effects.	As for Scotland but excluding combined effects.	
5	Flood defence schemes	Details available showing type, standard of service and area protected.	Details not fully available.	
6	Minimum standard of service for flood defences	100 year return period plus climate change allowance.	No minimum standard outside the centre of London.	
7	Benefit cost assessment for grant aid for flood defences.	Benefits must exceed costs.	Priority scoring system effectively means benefits must be five times costs to receive grant. In practice benefits have had to be six times costs for recent projects.	
8	Authority to build flood defences.	Only the local authority and relevant riparian owners. This discourages them from floodplain development because they know they will have the problem of defending it and will be democratically accountable.	Around 600 separate bodies, under the general supervision of the Environment Agency. Planners have no need to worry about finding the money for flood defences so no incentive to avoid flood hazard areas.	
9	Sustainable flood management	Requirements under primary legislation (WEWS Act 2003). Major natural flood management demonstration projects in River Devon catchment and elsewhere.	No legal requirement. Single demonstration project discontinued in 2007 due to lack of funding.	
10	Water Framework Directive	Transposed subject to sustainable flood management requirements.	Modification of rivers and lakes to cope with heavier rainfall events and thus reduce flooding risks is forbidden.	
11	Cleaning watercourses of vegetation and debris. (An increasing problem due to Japanese Knotweed, Habitats Directive, Water Framework Directive and Waste Directive)	Statutory duty on local authorities with central grant funding. For example, Falkirk council now clean some watercourses on a weekly basis due to fly tipping.	No statutory duty and no funding. Habitats Directive used as an excuse to avoid clearing watercourses. Fly tipping will be a growing problem.	
12	Artificial land drainage. (Causes increased run off into rivers.)	Figures not available, but Scottish topography is less suitable for major land drainage schemes. One of the biggest schemes is in Moray.	5 million hectares drained by 1900. Accelerated by the Wars and farming subsidies	
13	Sewage	New developments not allowed if the sewage or water supply systems do not have surplus capacity. Hence the almost universal use of SUDS	New developments may be connected to sewage systems even if they are already overloaded. (Water Industry Act 1991).	
14	Sustainable Drainage Systems. (SUDS)	Required for every new development. FLAGs have been invaluable in spreading best practice such as drainage impact assessments for the 200 year event.	Not always used due to uncertainty over ownership or responsibility issues. Anecdotal evidence of inappropriate systems which can increase the flood risk.	
15	Sustainable Drainage Systems. (Maintenance)	WEWS Act makes provision for Scottish Water to set standards for SUDS and to adopt and maintain schemes.	No maintenance standards or agreement on who will maintain.	
16	Record of flood events.	All non agricultural flood events no matter how small must be recorded and details published every two years along with action taken or proposed to prevent a recurrence.	No formal systems	
17	Flooding from agricultural land.	The Roads (Scotland) Act 1984 gives local authorities power to require farmers to prevent mud escaping from fields onto roads. This can be done by aerating soil, not ploughing to the edge of low lying fields, and by planting hedges and other barriers.	No action taken to prevent.	

18	Social housing and contents insurance.	57% take up of insurance following £500,000 spend by the Scottish Executive.	39% take up of insurance.	
19	Housing density	30 dwellings per hectare are considered high density.	Average 40 dwellings per hectare for new developments. Thames Gateway will have 200 dwellings per hectare.	
20	Water undertakers	Scottish Water is publicly owned and responsible to ministers. Westminster tried to sell it off for £5bn, but the Scottish Parliament vetoed the move.	Fully privatised.	
21	Completing of flood defences.	Targets announced for the completion of flood defences for the 100 year return period event by 2008.	No target for completion. New buildings are being constructed in hazardous areas faster than defences can be built.	
22	Building Regulations	Building Standards deal with mitigating the damage to buildings and removing the threat to the health and safety of occupants as a result of flooding. Guidance is given on the use of building materials that are not adversely affected by flood water. The Building (Scotland) Regulations 2004 Standard is relevant to new buildings prone to flooding (Scottish Buildings Standards Agency, 1996):	In the Building Regulations (England and Wales – The Building Regulations 2000 (SI 2000/2531) (as amended)) there are only limited provisions for flood mitigation. Approved Document C provides practical guidance on site preparation and resisting contaminants and moisture. It does not provide information on preventing or reducing the impacts of flooding. Approved Document H provides practical information on drainage and waste disposal and deals with the mitigation of flood risk associated with the surcharge of drains and sewers.	
23	Insurance	A survey by ISL Ltd (a company which administers quotation systems for household insurance) published in "Scotland on Sunday" on 12 November 2006 found that householders in flood-risk areas in Aberdeen, Glasgow, Edinburgh and Perth could significantly reduce their annual building insurance premium by switching to one of the insurers which recognise that flood risks are being well managed in Scotland. Specifically, homeowners in flood-risk areas of Perth could save £117.20, in Glasgow £143.46, in Aberdeen £75.11, and in Edinburgh's Stockbridge, which flooded in 2000, £92.36. (http://scotlandonsunday.scotsman.com/business.cfm?id=1671912006 downloaded on 6 May 2007.)	Insurance policies in floodplains are often subject to large excesses, typically £10,000 as well as premium loadings. For example, NU apply an excess to policies which have paid out flood claims. The excess equates to ten percent of the claims payment. There is anecdotal evidence of excesses up to £50,000 for a household policy.	
24	Deprivation index.	Index of multiple deprivation is calculated at a higher resolution than England. Their "data zones" average 200 houses and are similar in size to Census Enumeration Districts.)	Index of Multiple Deprivation produced by the Department of National Statistics, which ranks electoral wards based on an assessment of a mix of economic indicators.	
25	Target lists for evacuation of vulnerable people.	Thanks to advice from FLAGs, many emergency planning officers have established lists of people requiring special assistance for evacuation.	No action known.	
26	Communications in an emergency	Planning policy SPP7 specifies that mobile phone base stations and electricity sub stations should be located in such a way that they cannot be disabled by flood events	No special treatment.	
27.	Waterborne pathogens	Cryptosporidium (Scottish Water) Directions 2003 introduced monitoring which found that cryptosporidium and E. coli were found in 14 of Scotland's 32 council areas in 2004, which suggests that the problem could be widespread in England too.	No controls known. A flood in the USA resulted in 400,000 people falling ill from cryptosporidium in 1993 and 100 died. Since then there have been over 2,000 recorded cryptosporidium incidents in Britain. Current British water and sewage treatment plant does not kill the pathogen which is often fatal for children and old people. The most recent outbreak was in Wales in summer 2008 due to heavy rainfall.	
28	Flood Rescue	There is a statutory duty for fire and rescue services to provide flood rescue cover. Senior officers regularly attend FLAGs and discuss issues with insurers and other stakeholders.	No legal obligation to rescue flood victims. The Chief Fire Officers' Association warns that many areas do not have trained personnel or appropriate equipment for flood rescues.	
29	Population issues	In Scotland, where the birth rate has reached a 13 year high, the population is still expected to only increase from 5.1 million to 5.4 million by 2031.	England's population is expected to increase from 50 million to 60 million by 2031 according to the National Office of Statistics figures published on 12 June 2008. According to the Migrationwatch think tank some 70% of this increase will be driven by immigration. This means that England will face high costs of integrating 191,000 immigrants each	

			year as it becomes an increasingly multicultural society. Already the population of England has increased by a million in the last three years. DCLG says that a third of the millions of new homes needed in England will be required for immigrants. New estimates are expected to show at least 38 % will have to be built for immigrants. Social cohesion will become a growing problem in England, especially as climate change is likely to increase immigration figures.	
30	Maps of areas at risk from reservoir failure	Freely available to emergency planners, police and rescue services so that contingency plans can be drawn up.	Secret even from the police on the grounds of national security. (The police in England are apparently regarded as a security risk.) No area has proper dam break contingency maps.	

Appendix 6: The "Crichton Risk Triangle" (© Crichton, 1999)



In this definition, risk is a function of hazard, exposure and vulnerability and is represented by the area of the triangle. If any one side of the triangle can be reduced then risk is reduced. The concept can be used for any type of risk. In this paper it is used mainly to discuss flood risk.

Hazard

In the case of flooding, "Hazard" represents the frequency and severity of rainfall events or storms. Climate change predictions indicate an increasing hazard over which society has little immediate control other than to clean watercourses, provide adequate drainage, and adopt natural flood management practices. Insurers can help by encouraging the authorities to follow best practice from around the world, and in particular by explaining the critical importance of maintaining drains and watercourses. In Scotland, insurers have the added advantage of being able to take legal action against authorities which fail to maintain watercourses, and this ensures that local authorities listen to their advice.

Exposure

This represents the density and value of property located in flood hazard areas. The planning system can stop the increase in exposure to flood hazards, but there are still other things that can be done. Exposure can be controlled by the planning function. It can even be reduced, by buying properties in flood risk areas and demolishing them as has happened in London Ontario and after floods in the USA. Already it is much lower in Scotland than the rest of Britain.

Vulnerability

Vulnerability can be reduced by tougher building regulations, such as those found in Scotland. Even for existing buildings, vulnerability can be reduced in the longer term by introducing retrospective regulations so that if a building is damaged by flood or storm the insurer is forced to reinstate to the latest standards. There is already a precedent for this with fire insurance. At the request of the Scottish Building Standards Agency, the senior managers of all of the leading insurers have been visited to explain and discuss this point and they have all confirmed that compulsory resilient reinstatement would be quite acceptable to them as long as there is the level playing field of legislation and a lead in time so premiums can be adjusted[35]. Scotland now has enabling legislation to allow this to be introduced.

[35] Clark, M., Priest, S. J., Treby, E. J., Crichton, D., 2002 "*Insurance and UK Floods: a strategic reassessment."* A Research Report for TSUNAMI (now the "Risk Group"). University of Southampton, Southampton.