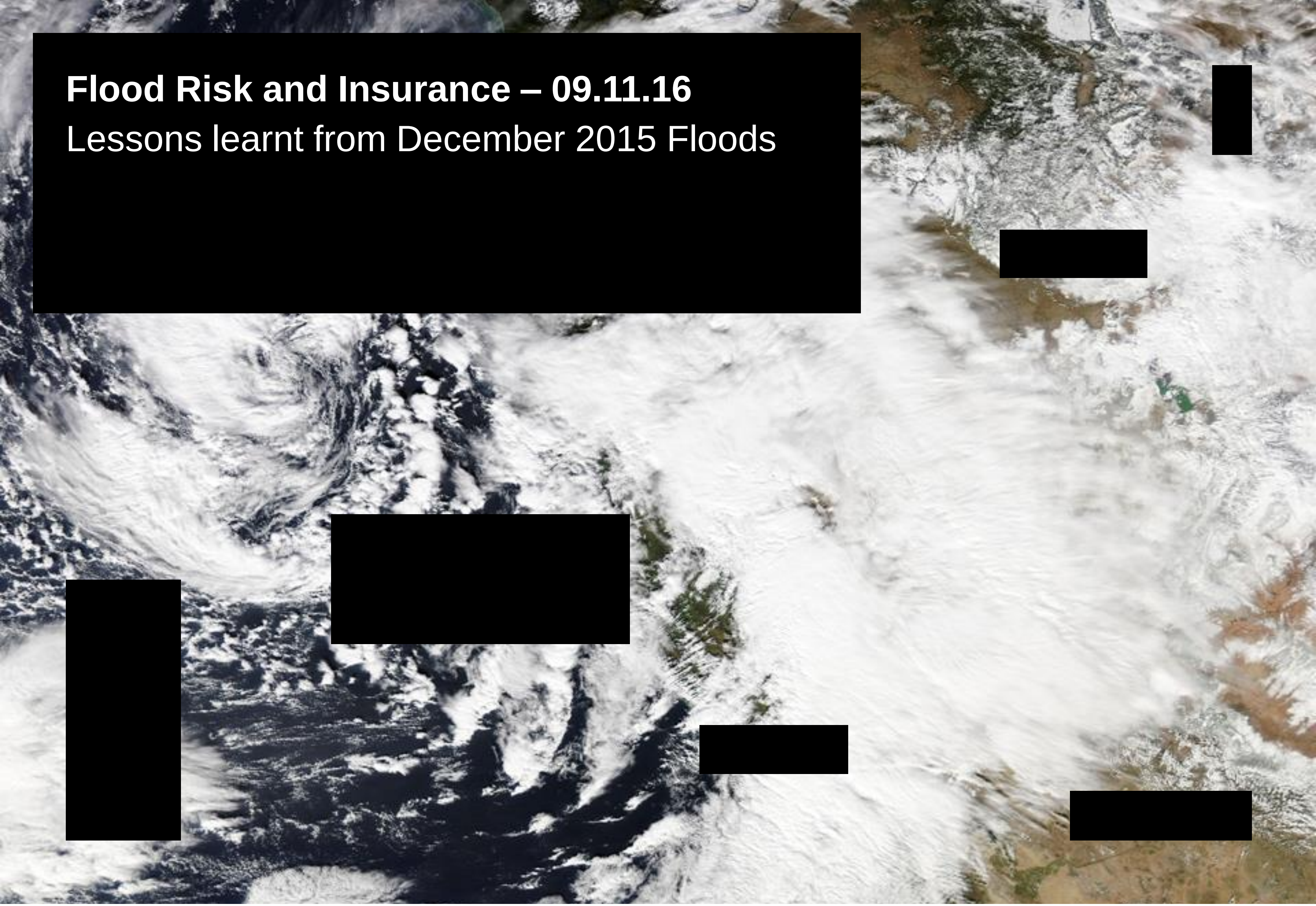
Flood Risk and Insurance – 09.11.16

Lessons learnt from December 2015 Floods



Willis Re

Media Messages

Sensationalist reporting!

December 2015 was wettest month ever recorded in UK

All-time rainfall records smashed by December deluges, says Met Office

Cameron to review flood defence spending

December 2015 The Wettest Since Records Began

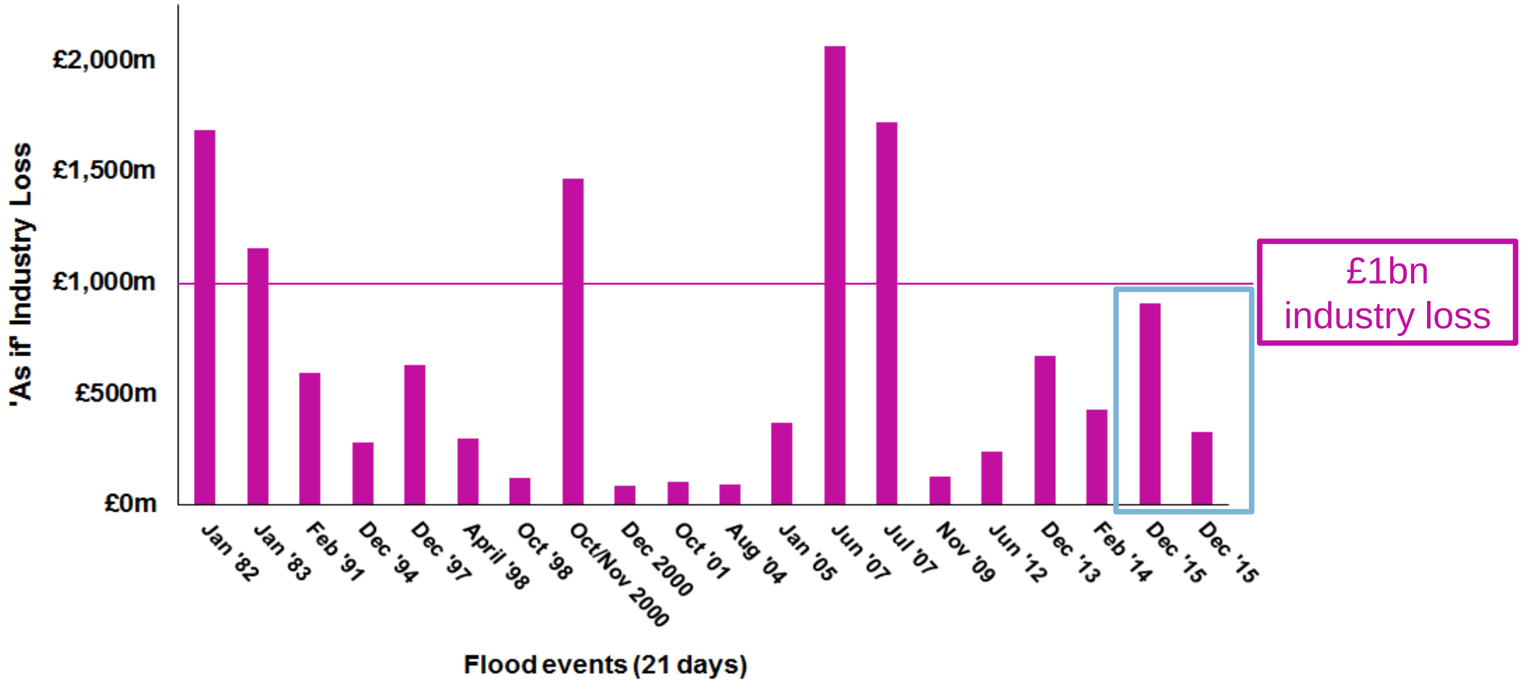
Claims flood defence spending up 'essentially meaningless'

UK weather: Warmest December on record was one of wettest ever seen as Britain battered by storms and flooding

Storms Desmond, Eva and Frank brought waves of devastation to many parts of the UK

Putting the December event into context (1982-2016)

From a market loss perspective December was not an extreme ‘event’



Losses - 5 events larger than December ‘15

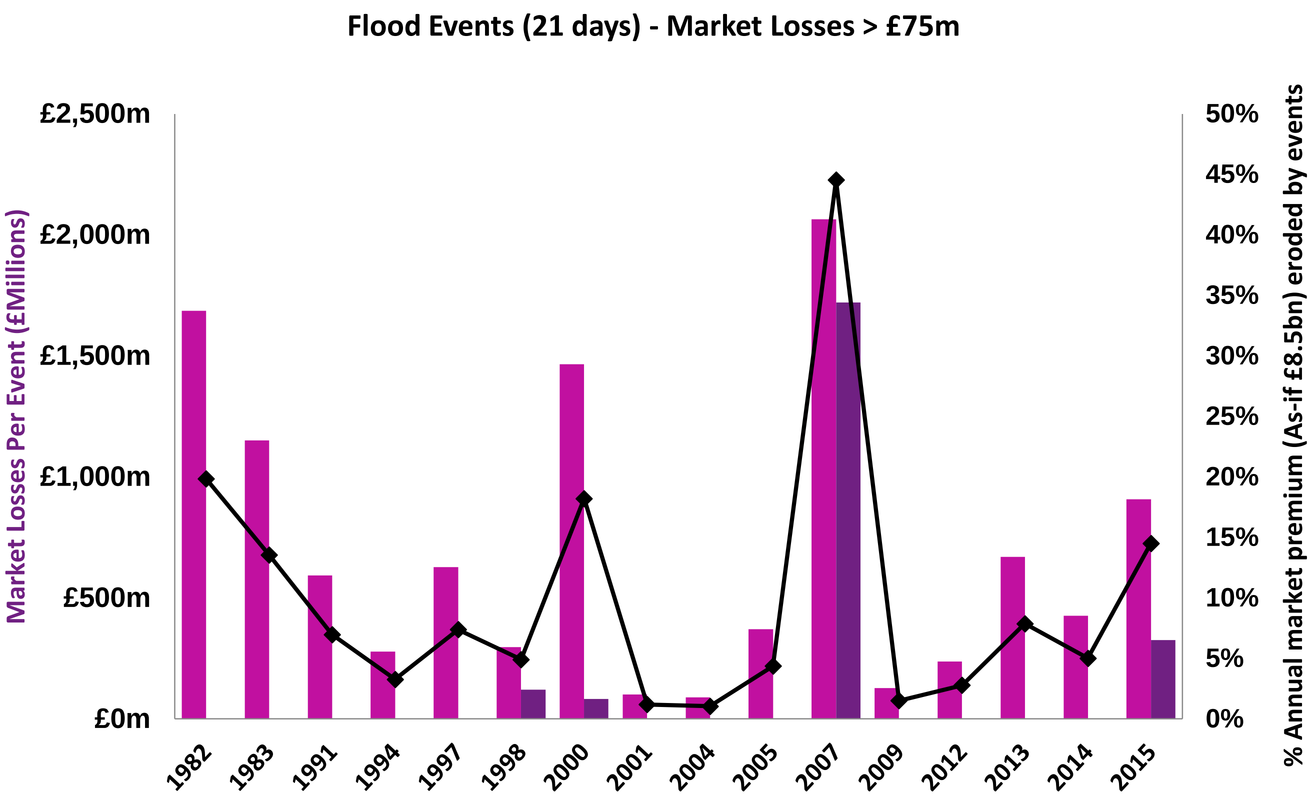
- In 21 day ‘market standard’ windows
- December 2015 event spanned 26 days; max 21 day period covered Desmond and (part of) Eva claims

Hazard – what happened?

- Rainfall - event driven by an ‘atmospheric river’ or clustering of rainfall
- River flows - extreme flows locally, yet severe flooding was not observed over a wide area

Industry Losses from Flood Events

Flood risk is an earnings volatility issue



Over the 35 year observed period, flood events have accounted for more than 10% loss ratio 5 times….

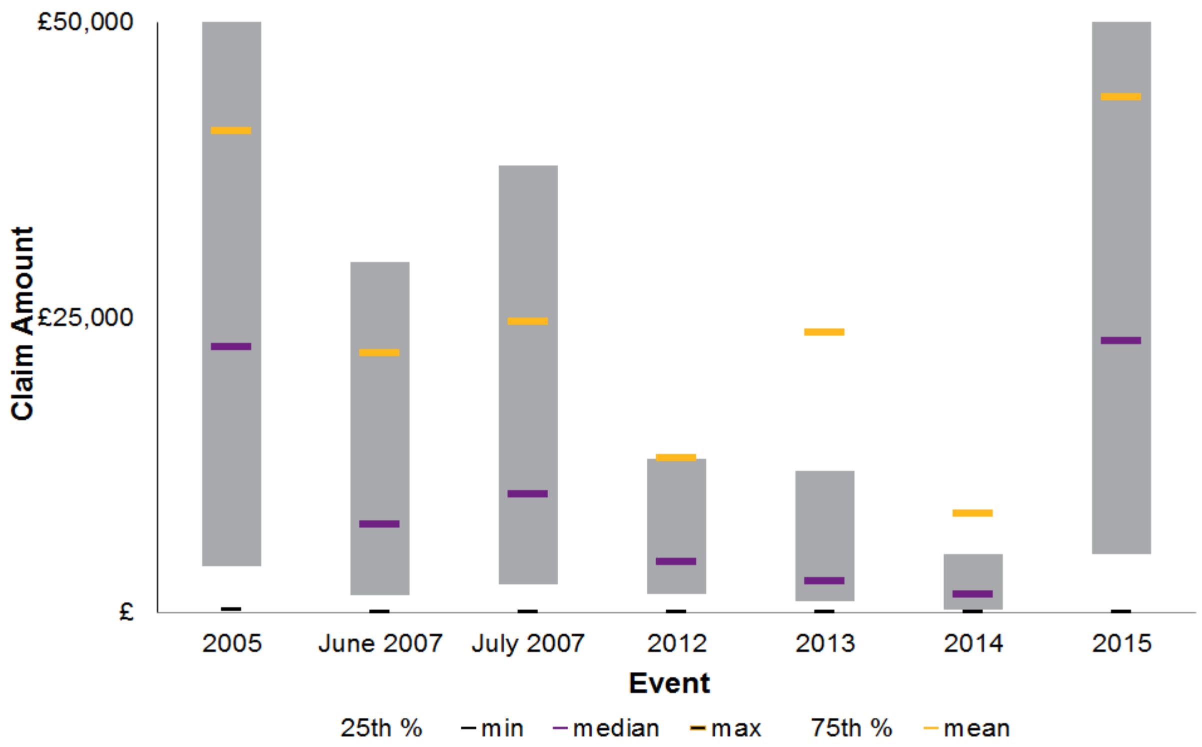
…. though flood losses have not typically triggered reinsurance recoveries

These losses are often retained by primary insurers

Putting the December event into context

Average claims size was significantly higher than prior UK events

Average claim size varies significantly across events
25th, median and 75th percentile claims size



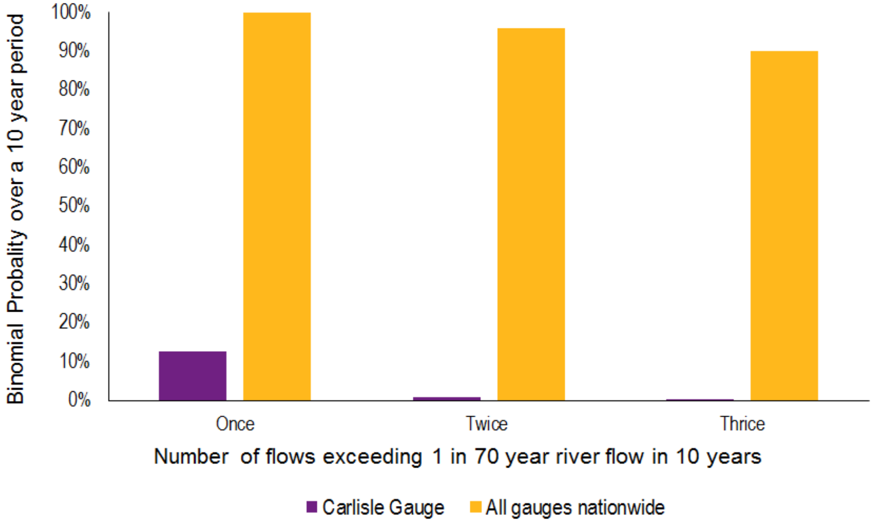
Factors driving differences

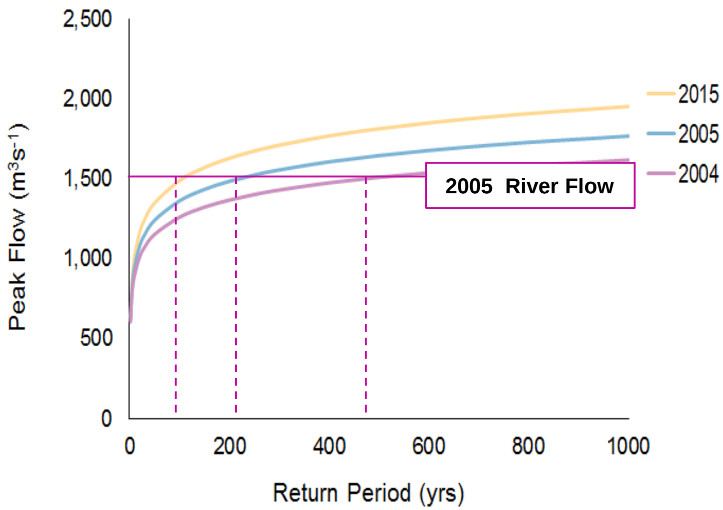
- Type of risks affected
- Replacement cost values
- Duration and water depth
- Catchment characteristics

Source: The Guardian

A detailed review of the December event

We should regularly expect flows of the magnitude seen in Carlisle in ‘05 and ‘15





Source: Matt Horritt

The chances of the flow becomes a near certainty at a national level

- Exceeding a threshold more than once at a local level is small
- Exceeding a threshold when considering the whole nation is large

The probability of the flow changes the more it happens!

Eden, Carlisle (peak flow return period) :

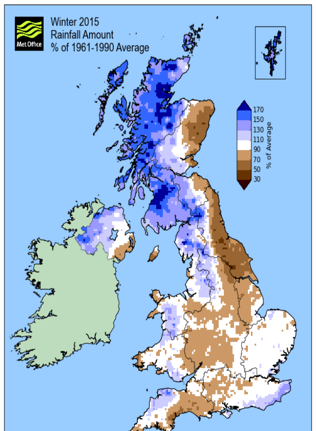
- Prior to 2005: 450 yrs
- After 2005: 220 yrs
- After 2015: 70 yrs

How do we quantify the chances of such events occurring?

A caveat - hazard return periods can be deeply misleading!

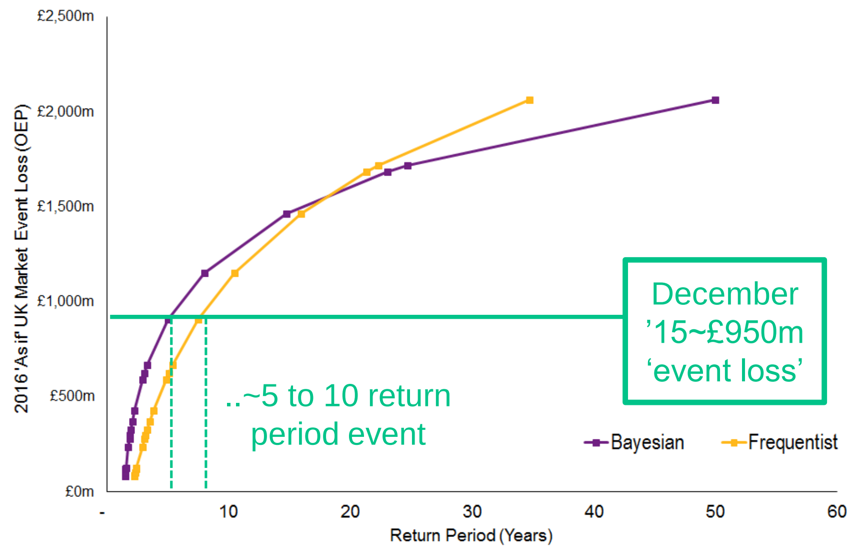
Extreme rainfall led to extreme flows in North-West but not across the country…

….while extreme river flows do not always lead to extreme losses at an industry level



Winter 2015 rainfall totals against long-term average

Rank of Flows '1982-2015' (red = high rank, green = low rank)

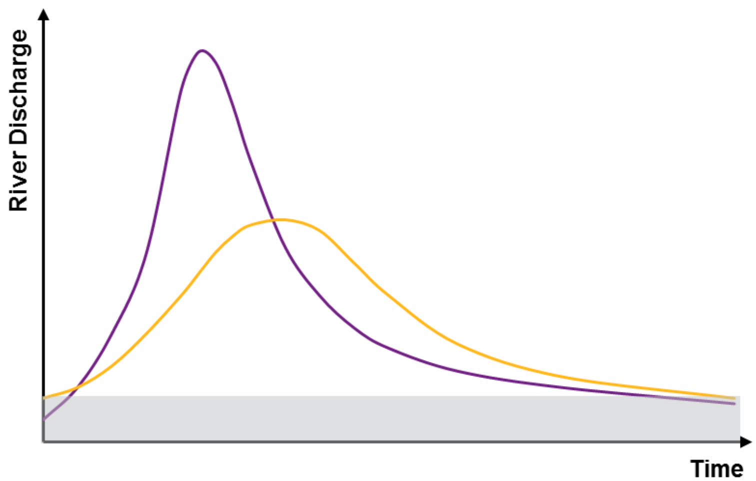


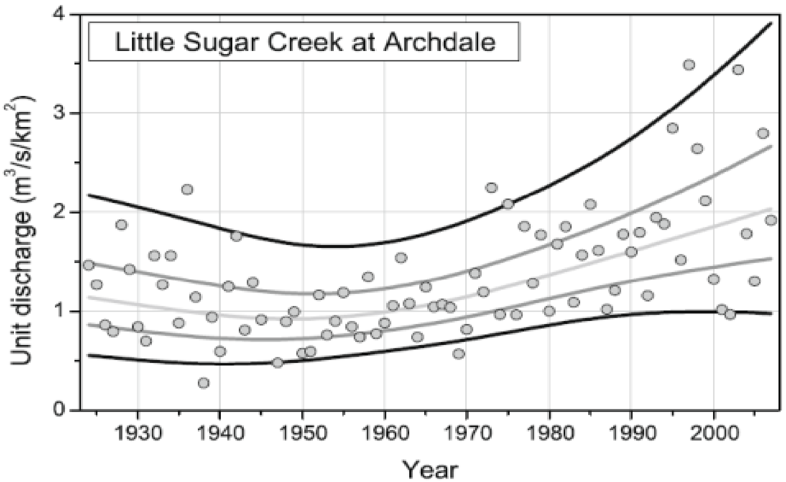
From a loss perspective Willis believes the December '15 event was a ~ 5 to 10 year event

- Rainfall can be highly localised and just bad luck
- Antecedent conditions can vary – it is unlikely that the same areas get repeatedly hit, though this clearly does happen
- Unique catchment features can remove the link between rainfall, flows and losses – e.g. flood alleviation schemes (e.g. dams, channels), catchment characteristics (e.g. steepness, porosity)

An insight to flood loss trends

Urbanisation drives changes to flood risk over time





Yes, it significantly changes the response time of rivers:

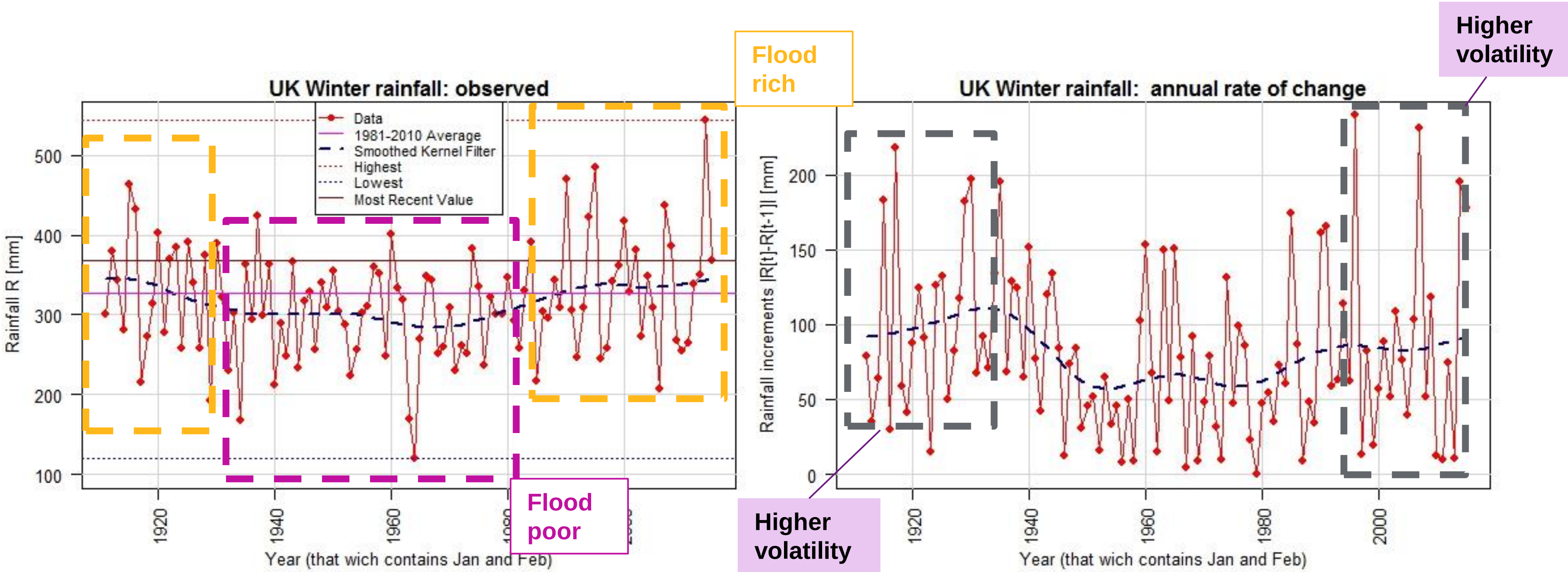
- Urbanisation and land use speed up time of water passing through catchment
- River training (i.e. dams, canals, channelisation)

River flow extremes shown to increase following urbanisation:

- Increase in impervious surfaces
- Future development on floodplains

UK rainfall inter-annual variability (1911-2015)

There is though a greater prevalence of extreme rainfall in recent years



Inter-annual rainfall trend

- Natural oscillation depicts flood-rich and flood-poor seasons
- The trend indicates that we are currently within a flood-rich period

Variability increasing

- Natural variability is higher during flood rich periods
- Extremes occurring during the recent years are expected

Reviewing Flood Models: different approaches and uses

The industry relies on a model that only predicts 32% of historical claims

How model performance is assessed – using December '15 as an example:

Model success?

- Claims in undefended flood outline (yellow dots) or flows exceeded assumed defences **(green dots)**.

Model error?

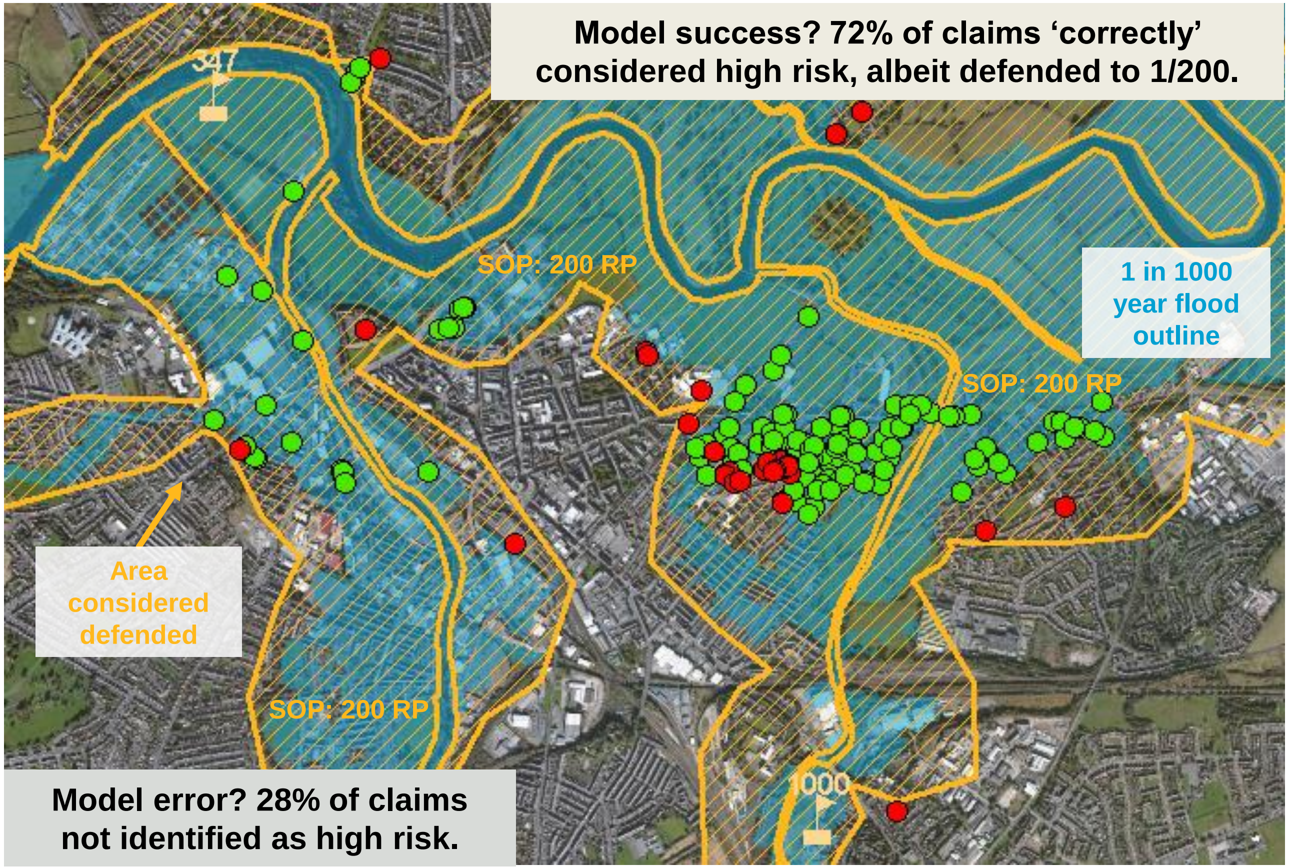
- Claims not identified as being at high risk **(red dots)**.

Flood Depth (Metres)	Return Periods (Years) 20	75	200	1000
>0 - 0.1	33%	21%	17%	9%
>0.1 - 0.5	45%	51%	49%	45%
>0.5 - 1	16%	18%	19%	22%
>1-2	5%	8%	12%	16%
>2-4	1%	2%	3%	6%
>4	0%	0%	0%	1%
No Vendor A Risk	89%	76%	71%	68%
Market All Events % captured	**11%**	**24%**	**29%**	**32%**

Underwriting model picks out 32% of claims – is this success of failure?
Claim counts falling in underwriting model – historical events 2005-2016

Reviewing flood models with December 2015 claims

Carlisle – model performed well but flow exceeded defence standards



Distribution of Claims - Carlisle

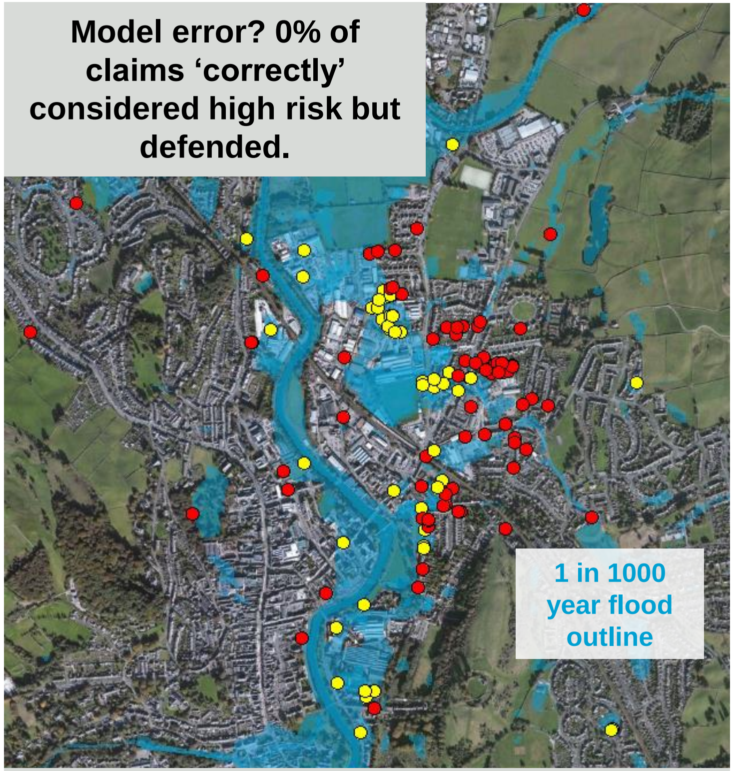
Claim Characterisation	% Contribution
In flood layer - Defended	72%
In flood layer - Undefended	0%
Not in flood layer	28%

Legend

- Claims within 1 in 1000 year flood outline - defended
- Claims within 1 in 1000 year flood outline - undefended
- Claims not within flood outline

Reviewing flood models with December 2015 claims

Kendal – model performed well but flow exceeded defence standards



Model error? 64% of claims not identified as high risk and undefended.

Distribution of Claims - Kendal

Claim Characterisation	% Contribution
In flood layer - Defended	0%
In flood layer - Undefended	36%
Not in flood layer	64%

Why the model error?

- Not all flood risk was modelled – there is a cut-off below which small catchments are not modelled
- Local drainage failure – blocking of culverts and drains from the surface water run-off. Models are unlikely to capture this.

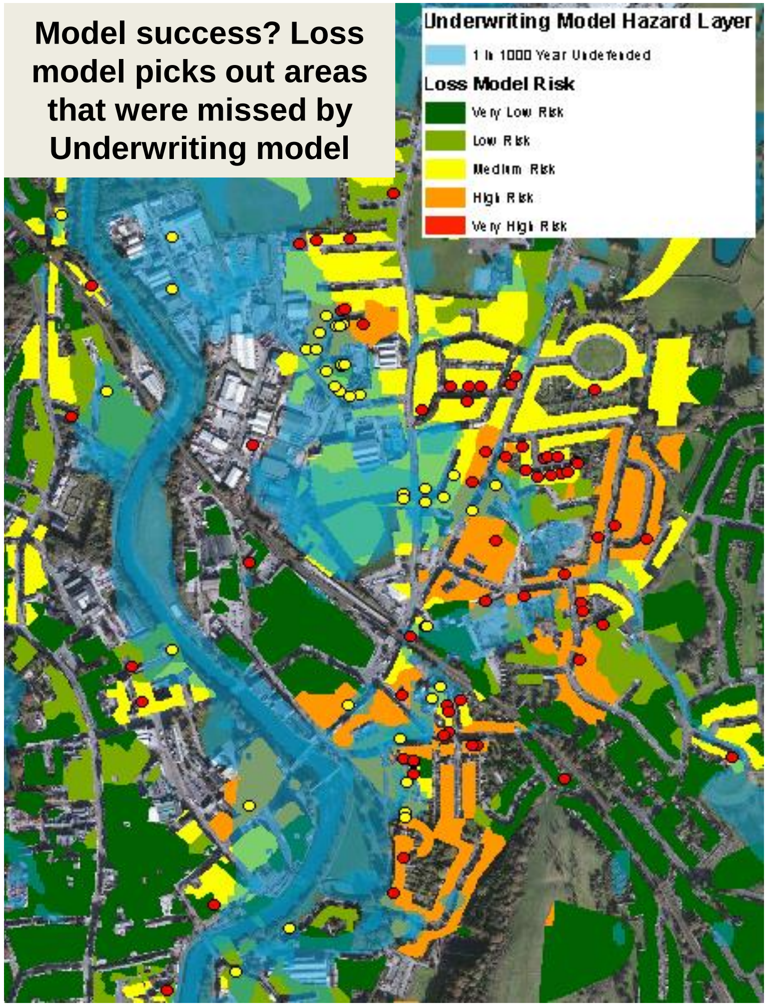
Legend

- Claims within 1 in 1000 year flood outline - defended
- Claims within 1 in 1000 year flood outline - undefended
- Claims not within flood outline

A multi-model approach

Incorporating a 'loss model' view of risk identifies additional claims – e.g. Kendal

Model success? Loss model picks out areas that were missed by Underwriting model



Loss model advantages

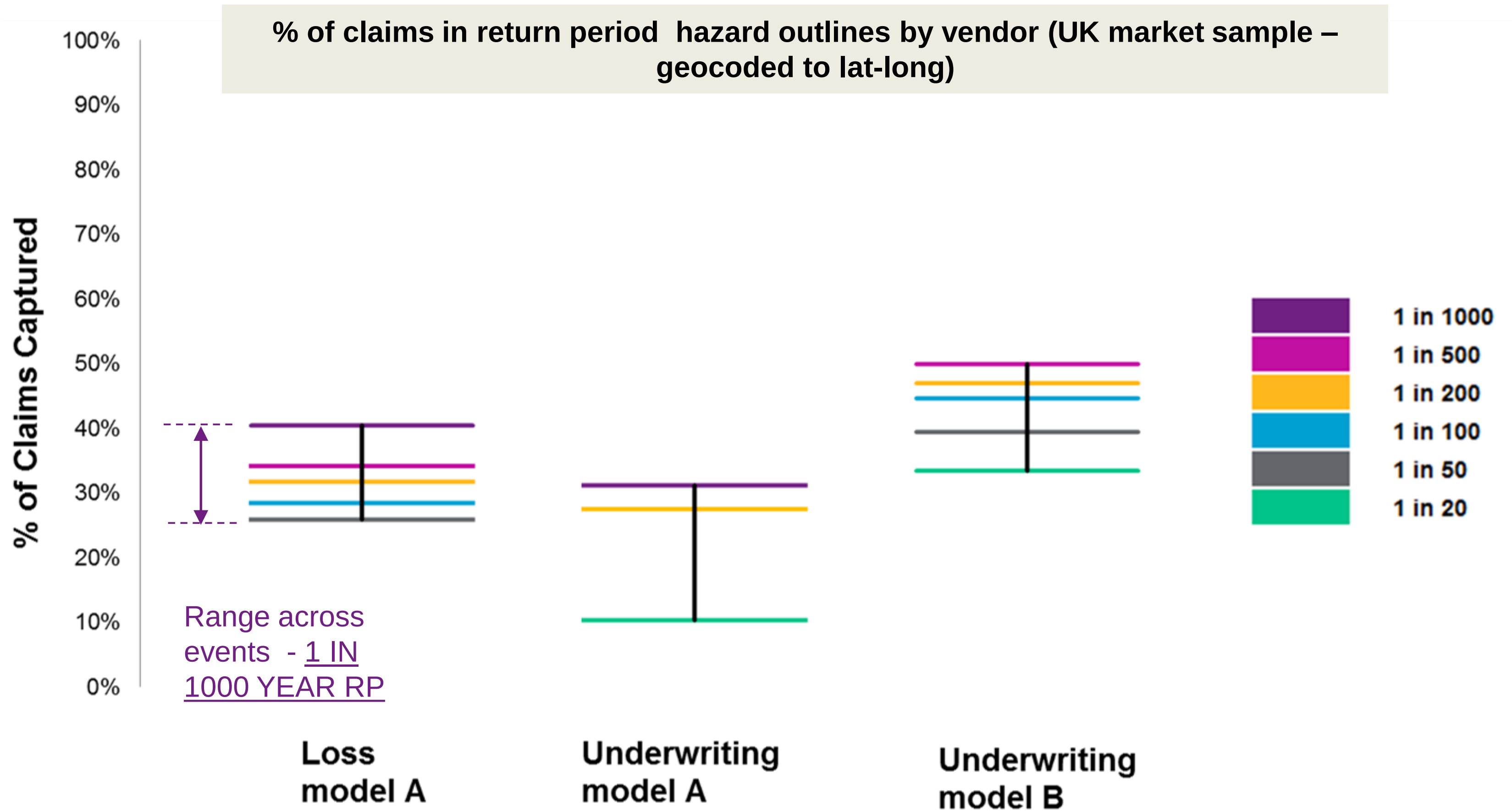
- **Identify additional areas** with claims that underwriting model does not
- Provides a risk premium per location
- Takes **correlation** of risks to each other into consideration

Legend

- Claims within 1 in 1000 year flood outline - defended
- Claims within 1 in 1000 year flood outline - undefended
- Claims not within flood outline

Reviewing flood models with December 2015 claims

So compared to 31% - how many claims does loss model capture?



Loss model performs well at identifying areas susceptible to flooding
Underwriting models can vary significantly in capturing claims

December 2015 floods: lessons learnt
Conclusions

December 2015

- Not an extreme event from a loss perspective, despite extreme localised weather
- High average claims size driven by the event characteristics
- We are in a flood rich period and expect localised extremes should not be a surprise to our industry

Multi Model approach: Addressing a modelling challenge?

- Earning issue for re/insurers
- Non-stationarity of risk requires adoption of latest datasets and analytics