Impact based warning – does it work?
The Met Office’s experience

Mark Bevan
Met Office Advisor (Civil Contingencies)

Regional Workshop on Impact-based Forecasts in Asia
Mark Bevan
Met Office Advisor (Civil Contingencies)

• Joined the Met Office in 2003
• Background in Defence Forecasting, including reserve military service overseas
• Forecaster at 2012 Olympic Games and 2014 Commonwealth Games
• Now part of a team of 19 Advisors spread across the UK
• Liaison between the Advisor team and the Chief Operational Meteorologist in Met Office HQ
• Responsible for communications with emergency responders in Devon, Cornwall and the Isles of Scilly
Content

• Introduction – why did we develop an impact based warning service?
• National Severe Weather Warning Service
  - development of the service (2009-2011)
  - current service
  - ongoing work to update the service (2015 onwards)
• Summary
• Questions
History of NSWWS

1987 - Michael Fish’s ‘Hurricane’ - 18 deaths, 15 million trees lost, hundreds of thousands of homes without power.

1988 - Government funded, meteorologically determined threshold based warning service begins
Severe gales/storms
Blizzards/drifting
Freezing rain/glazed frost/widespread icy roads

Heavy snow
Heavy rain
Widespread Dense Fog

**Early warnings** Issued when the forecaster had confidence that there would be “disruption” due to severe weather in the next 5 days.

**Flash warnings** When the forecaster had 80% or more confidence that there would be severe weather in the next few hours (up to 24 hours).

**Emergency Flash Warnings** These were issued with up to 24 hours notice (but usually much less than this) when extreme conditions were expected.

**Motoring Unit Warnings** There was a lower tier of warning aimed specifically at motorists. These gave warnings of rain, heavy enough to give spray and standing water, fog (visibility less than 200m), widespread ice, snow and wind.
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Blizzards/drifting
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2009 – research undertaken into how to improve the warnings service:

- 12 public focus groups
- 7 responder workshops
- Media meetings

‘Warning categories are too complex. Needs to be simplified’

‘Weather warnings should only be issued if severe weather is expected to have an impact’

2011 - Impact based NSWWS launched
So what is NSWWS?

- Impact based warnings service – providing warnings of Rain, Wind, Snow, Ice and Fog
- Forecast provides an **Expected Level of Impact** and a **Likelihood of this Impact** occurring - from this we define a ‘colour’ to attach to the warning (Yellow, Amber or Red)
- Thresholds (for example 50 mm of rain in 12 hours) are no longer used to trigger warnings, but may form part of the decision process
**Understanding Impacts**

Emergency responders defined the levels of impact – ensures impacts in the warnings match their perceptions and pressures.

<table>
<thead>
<tr>
<th>Impact Levels for All Weather Types</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very Low</strong></td>
</tr>
<tr>
<td>On the whole, day to day activities not affected but some localised, small scale impacts occur</td>
</tr>
<tr>
<td>A few transport routes affected.</td>
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### Understanding Impacts

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<tr>
<td>On the whole, day to day activities not affected but affected.</td>
</tr>
<tr>
<td><strong>‘NORMAL WEATHER’</strong></td>
</tr>
<tr>
<td>Some transport routes and travel services affected. Some journeys require longer travel times.</td>
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<td></td>
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</tbody>
</table>
Some questions to consider
Forecast uncertainty?
Impact uncertainty?
Intensity of weather?
Time of day?
Time of year?
Location? Rural or urban?
What is ‘normal’ for the area?
Local vulnerabilities?
Recent conditions?

Consult Civil Contingencies Advisors
Seek information from emergency responders & partner organisations

Finalise and issue (or update) warning
Monitor weather / forecast & impacts

Some questions to consider
Are the impacts as expected?
Are the timings as expected?
Are impacts within the warning area?

The Process

GATHER INTELLIGENCE

Forecast of ‘severe weather’

Review Warning

Evaluate & Update

ISSUE
What is the message?

Widespread low impacts

Isolated medium impacts

Convective

Dynamic
What is the message?

Convective?

Dynamic?

Isolated medium impacts

Widespread low impacts
Where do the warnings go?

- Television and Radio
- Hazard Manager web service for responders
- Email
- Public Website
- Social Media
- Mobile App
Past Event – South Scotland
3 January 2012

A deep area of low pressure tracked across northern parts of Scotland bringing gale to severe gale force winds across the UK with Scotland’s Central Belt worst affected.

Synoptic Chart at 0600 on Tuesday 3rd January 2012
A warning was originally issued on the 31\textsuperscript{st} December 2011 and updated on the 1\textsuperscript{st} January 2012 suggesting gusts of 60-70 locally 80 mph.
An Amber wind warning was issued on 2nd January 2012 suggesting gusts of 70-80 mph locally 90 mph through the Central Belt.
An Red wind warning was issued on 3rd January 2012 suggesting gusts of 85-95 mph through the Central Belt.

The Met Office have issued a Red Warning of Wind

Valid from 08:15 on Tue, 03rd Jan 2012 until 12:00 on Tue, 03rd Jan 2012

Storm force winds will affect the central belt of Scotland at first this morning, leading to widespread disruption to travel and the potential for damage to buildings. Gusts will reach 85-95 mph.

For more details please go to: http://www.metoffice.gov.uk/weather/uk/uk_forecast_warnings.html

Issued by the Met Office at 08:14 on Tue, 03rd Jan 2012
Wind gusts of 75-85 knots (86-97 mph) occurred through the Central belt with a gust of 89 knots (102 mph) at Blackford Hill, Edinburgh.
Past Event – South Scotland
3 January 2012

• Rail services from Edinburgh to Glasgow were suspended
• The Forth, Tay and Kingston road bridges were closed
• Ferry services were delayed and flights cancelled
• 100,000 Scottish homes and businesses were left without power
• Several buildings were damaged
• Fallen trees blocked roads and rail lines

It was very windy across other parts of the UK too with severe disruption and 2 deaths.
Does it work? – Verification of individual Warnings

All Amber and Red warnings a subjectively verified after the event.

Assess the warning in terms of: Impact Level (0-3)  Impact Timings (0-3)  Impact Location (0-3)

Impact information sought from: Responders  Media Reports  Social Media

Verification carried out internally then subject to external audit – rolling two year average.

Target of 72% of warnings scoring 6 or more (rising to 80% by 2020), with less than 20% scoring 3 or fewer.
Does it work? - Feedback

Feedback is regularly sought from both Emergency Responders and the Public

Responders surveyed every two years. Met Office Advisors attend debriefs after severe events

Public surveyed by telephone after Amber or Red Warnings are issued
Does it work? - Feedback


92% of Responders are satisfied with NSWWS

82% feel they get about the right number of warnings

86% say they use the weather impact matrix

To what extent are you confident or not in your ability to use the National Severe Weather Warning Service weather impact matrix to assist you in making decisions?
25% of responders made suggestions for improvements

I appreciate this is difficult but I feel there are too many yellow warnings which can neutralise the impact of the service. However, by their nature these will be more frequent...... Perhaps consider yellows as alerts or risk awareness raising whereas continue to provide warnings for amber or red scenarios.

Make the access to the systems using a tablet easier, at the moment there seems to be limited functionality using a tablet or smart phone. Perhaps an app would be of benefit?

Fewer warnings. Seem to get far too many warnings when there is high wind or rain which is just normal winter weather.

If there was a way of making it more regional as the emails cover national information and I only need to see information relevant to my region.

Be more locally specific. This is why I usually wait for the Civil Contingencies Advisor to send it, rather than actively find and read it.
2015 responder workshops
Ad-hoc public surveys post event

Q) What action, if any, did you take as a result of the severe weather warning? For example, please think about whether you changed any plans to travel or how you travelled, etc. as well as anything you did around your property

- Secured things around the property: 34%
- Stayed in: 21%
- Left work early: 4%
- Changed travel plans: 4%
- Altered my work plans: 4%
- Cleared paths: 3%
- Did not drive: 2%
- Cancelled a planned activity: 2%
- Drove more safely/slowly: 1%
- Other: 28%
- No action taken: 24%

76% took action

A range of more individual and fragmented comments were included as ‘other’:

- “Kept the animals in and safe”
- “I made sure I had coal in. It was just as a back up in case electricity went off”

Q Base: 432 (all respondents who saw the specific warning)
Also investigate views of the service as a whole.

Q) Please can you tell me how important or unimportant each of the following elements of a National Severe Weather Warning are?

<table>
<thead>
<tr>
<th>Element</th>
<th>Essential</th>
<th>Very Important</th>
<th>Fairly Important</th>
<th>Not very Important</th>
<th>Not important at all</th>
<th>Don’t know/no opinion/not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy to understand</td>
<td>59</td>
<td>33</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clarity of information presented</td>
<td>51</td>
<td>39</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has local detail</td>
<td>56</td>
<td>33</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provided by a trusted supplier</td>
<td>51</td>
<td>37</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>54</td>
<td>33</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has useful information about how the forecast will change through the day/severe weather event</td>
<td>43</td>
<td>43</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provides an idea of how the weather will impact me</td>
<td>41</td>
<td>39</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forecasts far enough into the future</td>
<td>29</td>
<td>35</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has national detail</td>
<td>24</td>
<td>30</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
NSWWS – Next Generation

- Extend maximum lead time from 5 days to 7 days (in response to improved modelling and forecast capability)
- Add two new weather types to the scope of NSWWS – ‘Thunderstorm’ and ‘Lightning’
- Remove Weather Icons – use words to prevent misinterpretation
- Reduce meteorological jargon and emphasise impacts – use plain language
- Improve presentation of warnings - clarify overlapped areas during complex situations
  - improve public website and mobile app display
- Improve communication in short lead time situations
Addition of ‘Thunderstorm’ and ‘Lightning’ Warnings

Improve communication of severe convection – previously only option was to issue a ‘Rain’ warning.

Public testing showed that ‘Thunderstorm’ was understood as a combination of Heavy Rain, Strong Winds, Hail and Lightning

So...

Thunderstorm warning – to be used when all thunderstorm hazards are present

Lightning warning – for use when precipitation / wind is not expected to be a problem – for example elevated instability where lightning impacts on power networks are the main concern.
Remove Weather Icons – use words to prevent misinterpretation

Public research showed that the audience did not always identify the weather type correctly from icons alone.
Remove Weather Icons – use words to prevent misinterpretation

Is this snow?
Remove Weather Icons – use words to prevent misinterpretation

Is this snow?

Or ice?
Remove Weather Icons – use words to prevent misinterpretation

Is this fog?
Remove Weather Icons – use words to prevent misinterpretation

Is this fog?

Or a menu button?

The **hamburger** (also known as **options**), placed typically in a top corner of a graph
Remove Weather Icons – use words to prevent misinterpretation

Icons are being replaced with plain text

RAIN  THUNDERSTORM
SNOW  ICE
ICE  FOG
FOG  LIGHTNING
Feedback from the public showed that warnings were seen as too complicated – both in terms of language and display.

The matrix was not well understood by the public but remains in demand from Emergency Responders.

‘Too many warnings’ – especially low impact Yellow warnings
Improve presentation of warnings
Improve presentation of warnings
Too many yellows?
Warning types since 2011

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Impact</th>
<th>Yellow Warnings</th>
<th>Amber Warnings</th>
<th>Red Warnings</th>
<th>Total Warnings</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Low</td>
<td>66</td>
<td>17</td>
<td>12</td>
<td>2991</td>
</tr>
<tr>
<td>Medium</td>
<td>Medium</td>
<td>1836</td>
<td>218</td>
<td>16</td>
<td>276</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
<td>731</td>
<td>25</td>
<td>8</td>
<td>350</td>
</tr>
<tr>
<td>Very low</td>
<td></td>
<td>350</td>
<td>8</td>
<td>1836</td>
<td>Yellow Warnings</td>
</tr>
</tbody>
</table>

Low Impact 1902
Medium Impact 1316
High Impact 61
Changing forecaster behaviours

• Change in language use – less meteorological jargon.
  ‘An occluded front may bring 30 mm of rain in an hour this evening causing surface water flooding’

  Becomes:

  ‘There is a small chance that heavy rain this evening could lead to flooding developing rapidly.’

• ‘Chief Forecasters Assessment’ section renamed as ‘Further details’.

• Aim to reduce the number of low impact Yellow warnings – increase in risk appetite.
Naming storms

Since Autumn 2015 some severe weather systems have been assigned names as the impact on the UK and the Republic of Ireland. Either:

- Amber/Red warning for Wind (or system expected to require one)
- Amber/Red warning for another weather element, but with wind a significant factor.

This is a joint programme in partnership with Met Éireann, the Irish Met Service.
Naming Storms - Does it work?

https://www.brandwatch.com/
Naming Storms - Does it work?

Storm Desmond: CLIMATE CHANGE 'may have played a role' in deadly and unprecedented weather

CLIMATE change may have played a role in the "unprecedented" Storm Des has caused a "number of" deaths and devastated thousands of homes.
Summary

• NSWWS in general is well received and understood.

• Emergency responders benefit from the support of the Met Office Civil Contingencies Advisors which they view as ‘part of the service’

• Ongoing work to update the service in view of user feedback.

• Behaviours of the forecasters as important as the design of the service.
Any questions?

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