Natural Hazards PARTNERSHIP

The UK's trusted voice for coordinated natural hazards advice

From Hazards to Impact: Experiences from the Natural Hazards Partnership and the Hazard Impact Modelling project

Becky Hemingway, Met Office

Regional Workshop on Impact-based Forecasts in RA II (Asia)

Wednesday 8th November 2017

Met Office

“[People] want to know three things:

- **What does it mean to them?**
- **What does it mean to their family?**
- **What do they need to do right now?**

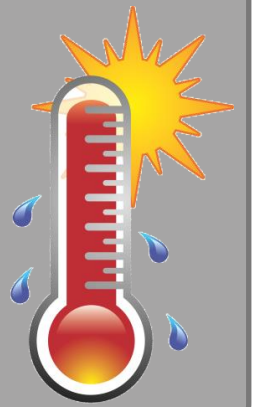
And so don’t speak like a meteorologist. Tell me what we need to know.”

(television meteorologist, quoted by Demuth et al. 2012)

There is the potential for 150mm of rain in an hour

Some places will experience 60mph winds today

Temperatures today will reach 35°C

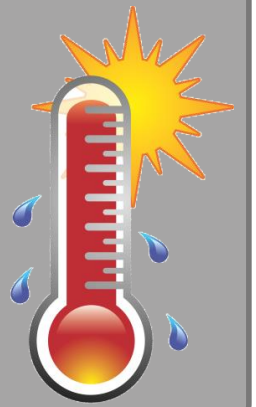


A volcanic ash advisory has been issued

150mm of rain in an hour will cause flooding, mitigating action is required

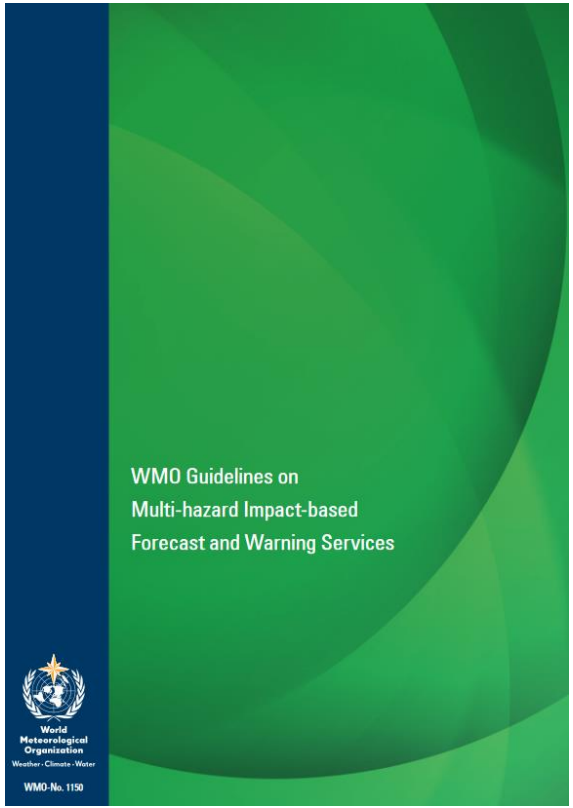
60mph wind gusts will cause travel disruption and fallen trees

At 35°C stay in the shade and drink plenty of water



Volcanic ash may cause disruption to air travel

Why do impact-based forecasting?



Each year the **impacts of severe hydrometeorological events** around the Earth give rise to **multiple casualties and significant damage** to property and infrastructure, with adverse economic consequences for communities that can persist for many years. All this happens in spite of the fact that many of **these severe events have been well forecast**, with accurate warning information disseminated in a timely fashion by the responsible National Meteorological and Hydrological Service (NMHS).

The **reasons for this apparent disconnect lie in the gap between forecasts and warnings of hydrometeorological events and an understanding of their potential impacts**, both by the authorities responsible for civil protection/emergency management and by the population at large. Put simply, while there is a realization of what the weather might be, there is frequently a **lack of understanding of what the weather might do**.

If this gap is to be closed, then an **all-encompassing approach to observing, modelling and predicting** severe hydrometeorological events, and the **consequent cascade of hazards through to impacts**, needs to be developed. Tackling this problem will require a **multidisciplinary and highly integrated** and focused endeavor. This is essential to ensure access to the best possible science, and the optimum services, to manage multi-hazard events today, and to provide the best possible evidence base on which to make the costly decisions on infrastructure needed to protect the population in the future as climate changes.

Natural Hazards Partnership

17 government organisations

Aim to provide **“coordinated and coherent advice to government, civil contingency and emergency responders during high impact weather events and natural disasters”**

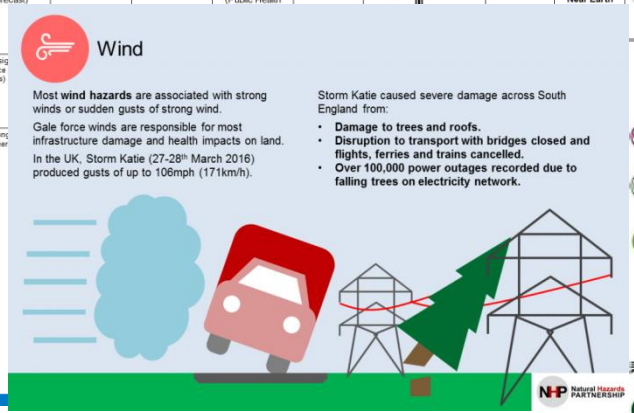
UK NHP Daily Hazard Assessment Colour State Matrix

Colour State	5-day UK (unless otherwise stated) Hazard Impact Assessment			5-day UK (unless otherwise stated) Hazard Forecast						UK Reported only Hazards		
	Weather - Rain, wind, ice, snow, fog, lightning, hail	Flooding - River, tidal, coastal, surface water, groundwater (England, Wales & Scotland only)	Volcanic Ash	Space weather (Earth impact forecast)	Landslide (24-hour forecast)	Wildfire	Extreme Temperatures (Public Health	Air Quality	Aero Allergens	Earthquake	Drought	Space Object Re-entry or Near Earth
Green	Disruptive weather not expected or low likelihood of minor disruption.	Disruptive flooding not expected or low likelihood of minor disruption.	Disruptive volcanic ash not expected or low likelihood of minor disruption	No sig space event(s)								
Yellow[1]	Low likelihood of significantly	Low likelihood of significantly	Low likelihood of significantly	Strong weather								

Cabinet Office

National Risk Register of Civil Emergencies

2015 edition



Committee on Climate Change

UK 2017 Climate Change Risk Assessment

UK Climate Change Risk Assessment 2017

Synthesis report: priorities for the next five years

NHP Natural Hazards PARTNERSHIP

Hazard Overview

April 2016

Wind

Overview

- Wind is the bulk movement of air caused by differences in air pressure.
- Air moves from high to low pressure along lines of equal pressure – isobars. The closer the isobars the stronger the wind.
- Wind is normally described by its average speed and direction over a 10 minute period.
- Gusts are a sudden, brief increase in wind speed.
- Surface vegetation and obstacles reduce wind speed as they increase friction. Winds are generally stronger over the sea. The highest winds occur on high ground.
- Wind is forecast in miles per hour (mph), measured in knots (nautical miles per hour), and can be reported using the Beaufort Scale. Standard (SI) units are m/s.

Wind in the UK

Large scale weather systems e.g. winter depressions and storms are the most common sources of strong wind and associated impacts. They can affect large areas and last for several days. Local winds e.g. squalls and downbursts and tornadoes from thunderstorms can occur. Mountain winds e.g. Lee waves and down slope winds can affect areas downwind of mountains and hills. These areas include east of the Pennines and in Cumbria. The prevailing wind direction is south-westerly (coming from the south-west), locations exposed in this direction can experience higher winds. Strong winds are often associated with rain or snow, this can cause amplified impacts.

Impacts

Wind impacts include:

Disruption to transport from falling trees on roads and railways, bridges closing, high-sided vehicles blowing over, ferry crossing being cancelled due to sea state, aircrafts not being able to land/take off.

Building damage due to fallen chimneys, dislodged roof tiles, trees falling on to buildings and flying debris.

Disruption to energy and telecommunications as electricity and telegraph wires are brought down, often by falling trees.

Health impacts directly from being physically blown over, flying debris, falling trees and road collisions and indirectly from post-storm clean up e.g. chainsaw injuries.

Notable wind events

6 December 2015 – Storm Desmond

27-29 October 2013 – St Jude's Day Storm

28 July 2005 – Birmingham tornado

18 October 1987 – 'The Great Storm'

More information can be found at: http://www.naturalhazardspartnership.org.uk/hazardsWind/

NHP Natural Hazards PARTNERSHIP

Science Note

2013

Advice provided by: Met Office; Public Health England

Other partners: Centre for Ecology & Hydrology; British Geological Survey; Cabinet Office; Department for Environment Food & Rural Affairs; Environment Agency; Government Office for Science; Health & Safety Laboratory; National Oceanography Centre; NERC; Ordnance Survey; The Scottish Government; SEPA; UK Space Agency; Scottish Environment Protection Agency

Wind

This Science Note is one of a series of short guides covering a range of natural hazards. These guides aim to provide non-experts with a brief introduction to each hazard and to highlight key aspects that may need to be taken into account in decision-making during an emergency involving this hazard. They are not intended to be fully comprehensive, detailed analyses or to indicate what will happen on any particular occasion. Instead they will signpost issues that are likely to be important and provide links to sources of more detailed information.

What is Wind?

Wind consists of the bulk movement of air. Measurements show that it is continually varying, due to turbulence. In the UK, it is normally described by its average speed and direction over a 10-minute period. Shorter duration peaks of wind speed are referred to as gusts. Most wind hazards are associated with strong winds. Surface vegetation and obstacles reduce wind speed, so the strongest winds are found at sea and on high ground. Strong winds arise from three types of weather system in the UK: large scale weather systems such as winter depressions; local winds such as squalls and tornadoes, associated with thunderstorms; mountain winds, such as lee waves and down slope winds that sometimes affect areas downwind of mountains/hills. Wind speeds of 34knots (39mph) or more are termed gale force and are responsible for most infrastructure damage and health impacts on land.

How does Wind affect the UK?

Over land, the highest winds generally occur on high ground, in coastal areas exposed to the prevailing south-westerly wind (i.e. wind coming from the south-west) and in the north where deep depressions are more frequent. Very strong low level winds may be associated with very intense depressions. However, strong winds associated with the outflow from thunderstorms (downbursts) can occur anywhere, especially in the south-east, and mountain winds are prevalent on the east side of the Pennines and Cumbria.

At sea, wind generates waves, and it is this combination that generally causes difficulties for shipping.

Wind can be especially variable (gusty) near fronts and thunderstorms and downwind of hills, cliffs and large buildings. Such variability affects control of vehicles on land, sailing ships on the sea and, especially, aircraft manoeuvring close to the ground.

Wind is a critical issue for building resilience. The varying climatology of wind strength across the UK is reflected in building standards to ensure safety of property and life. Design standards are also required to avoid creation of road and building

NHP Natural Hazards PARTNERSHIP

http://www.naturalhazardspartnership.org.uk

British Geological Survey; Centre for Ecology & Hydrology; Environment Agency; Health & Safety Laboratory; Met Office; National Centre for Atmospheric Science; National Oceanography Centre; NERC; Ordnance Survey; Public Health England; SEPA; Flood Forecasting Centre

Daily Hazard Assessment

Issued 13:53 on Wednesday, 11 January 2017

The Daily Hazard Assessment is intended to provide an 'at a glance' top level overview only. The links provided to the relevant Partner Organisations should then be used to obtain further and more detailed information as required.

Hazards Five Day Summary - EXTREME TEMPERATURES: AMBER, FLOOD: YELLOW, SNOW: YELLOW, WIND: YELLOW

EXTREME TEMPERATURES (ENGLAND):- A cold spell of weather will become established from Wednesday onwards with below average temperatures and snow in places.

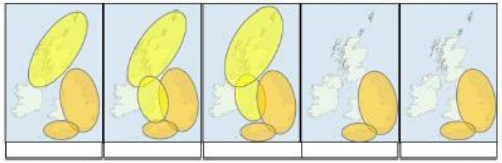
FLOOD:- There is a LOW coastal flood risk along the Suffolk coast today (Wednesday) with minor impacts possible. There is also a LOW coastal flood risk along the east coast of England on Friday (and into Saturday morning in Kent) with a very low likelihood of significant impacts.

SNOW:- On Wednesday snow is forecast to affect some areas of Scotland and Northern Ireland. On Thursday and Friday snow is forecast to affect a number of areas of the UK.

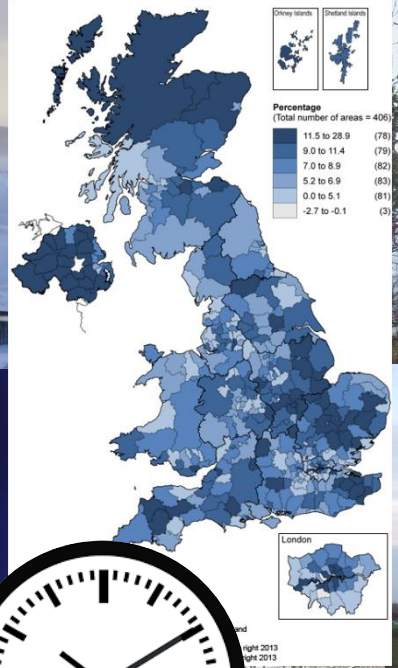
WIND:- Very strong winds during Wednesday and Thursday affecting parts of Scotland, Northern Ireland and some areas of northern England.

Hazards Five Day Summary Maps

Wednesday 11-Jan 1400 – 2359	Thursday 12-Jan 0000 – 2359	Friday 13-Jan 0000 – 2359	Saturday 14-Jan 0000 – 2359	Sunday 15-Jan 0000 - 2359

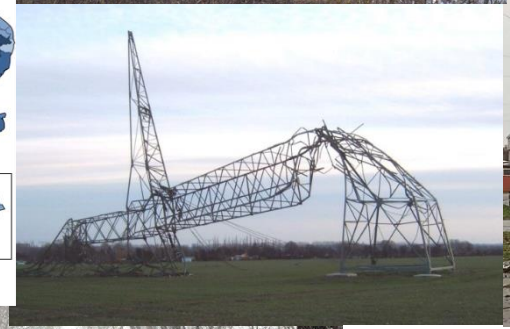


These maps provide an 'at a glance' indication of the natural hazards that could occur over the next five days. The area covered by each ellipse is indicative only to alert the user to which areas of the UK are at risk of a hazard. More detailed information will be found using the links provided. The highest level of alert will be shown, but each ellipse could indicate more than one hazard. For non-area specific hazards, the alert level is indicated by a coloured rectangle underneath the maps. Please see user guide on


Orkney Islands
Shetland Islands
Percentage
(Total number of areas = 406)
11.5 to 28.9 (78)
9.0 to 11.4 (79)
7.0 to 8.9 (82)
5.2 to 6.9 (83)
0.0 to 5.1 (81)
-2.7 to -0.1 (3)
London


POLICE
Joel Goodman

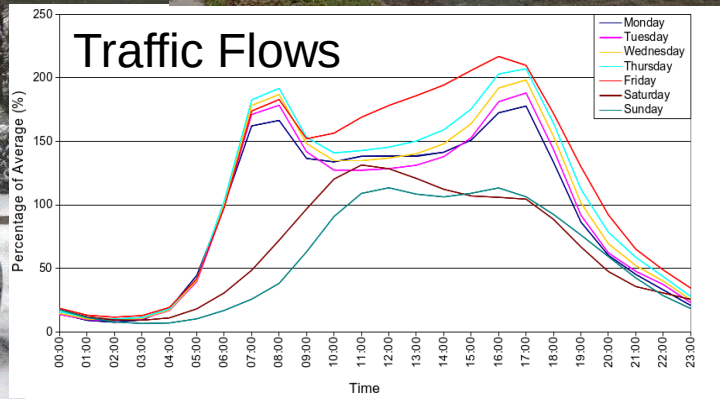

Cancelled
10:58 Windsor & Guildford
11:00 via Guildford
11:03 via Cobham
11:03 Teddington
11:05 Weymouth
11:06 Hampton Court
11:07 via Brentford
11:09 via Epsom
11:09 via Basingstoke
11:12 Basingstoke
Front 8 coaches
11:12 via Kingston
CityAM




@_chrishine/PA

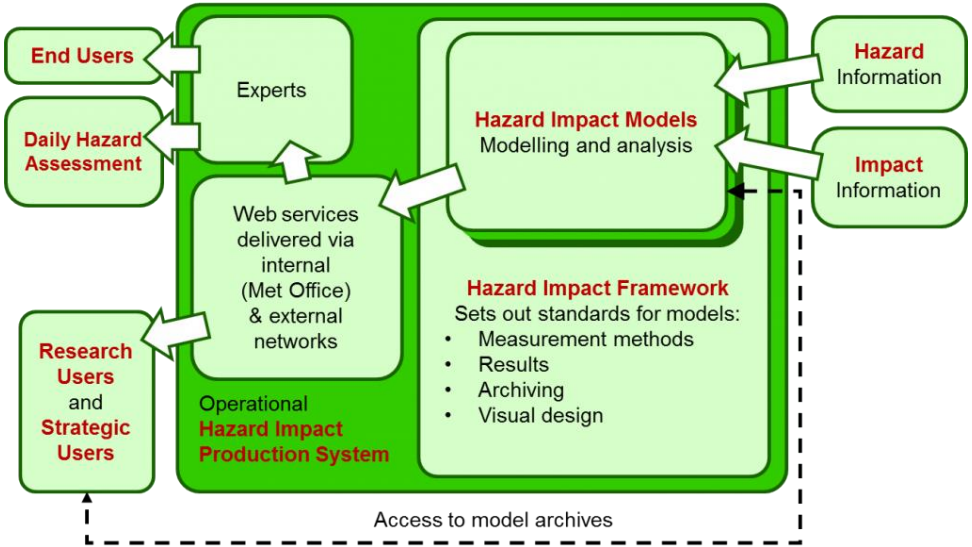

© Andrew McCaren/rossparry.co.uk


BD03 UHY


Traffic Flows
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday
Percentage of Average (%)
250
200
150
100
50
0
00:00
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time

NHP SCIENCE Hazard Impact Modelling Group

Hazard Impact Models and how they're created



How impacts are assessed

Impact Themes	Tier 2	Tier 3
Danger to Life	• Humans • Animals – Livestock / Wildlife	• Physical Harm / Evacuation • Disease • Psychological Ill-health
Denial of Access	• Key Infrastructure (Buildings)	• Emergency Services • Transport Hubs • Schools • Businesses / Local Amenities
	• Key Infrastructure (Networks)	• Energy • Water • Communications • Transport
Damage to the Physical Environment	• Buildings • Land	• Residential / Commercial Properties • Urban / Rural Land • Electrical Substations

www.naturalhazardspartnership.org.uk/science

Hazard Impact Models: Risk Algorithm

Hazard x **Vulnerability** x **Exposure**

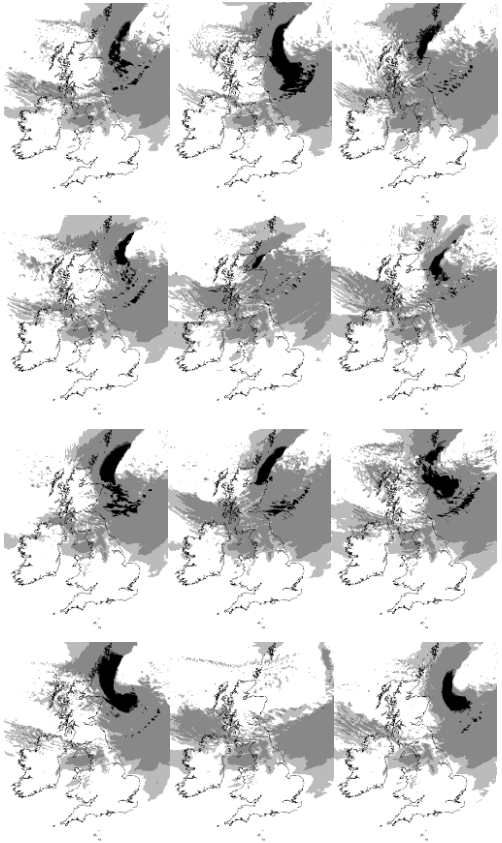
Wind Hazard Impact Models

Vehicle OverTurning (VOT) model

www.naturalhazardspartnership.org.uk/science/hims/sciencehimswind

Risk Algorithm: Vehicle OverTurning Model

MOGREPS-UK
- 2.2 km resolution
- 12 members
- 54 hours
- runs 4 times a day



Probability of max in last hour wind gusts exceeding thresholds

Actual Wind Gust Speed (m/s)

Weighted Wind Gusts

>30m/s

(70mph)

No thresholds passed

UHGV threshold passed (23m/s)

LGV threshold passed (26m/s)

Car threshold passed (35m/s)

All thresholds passed (36m/s)

0m/s

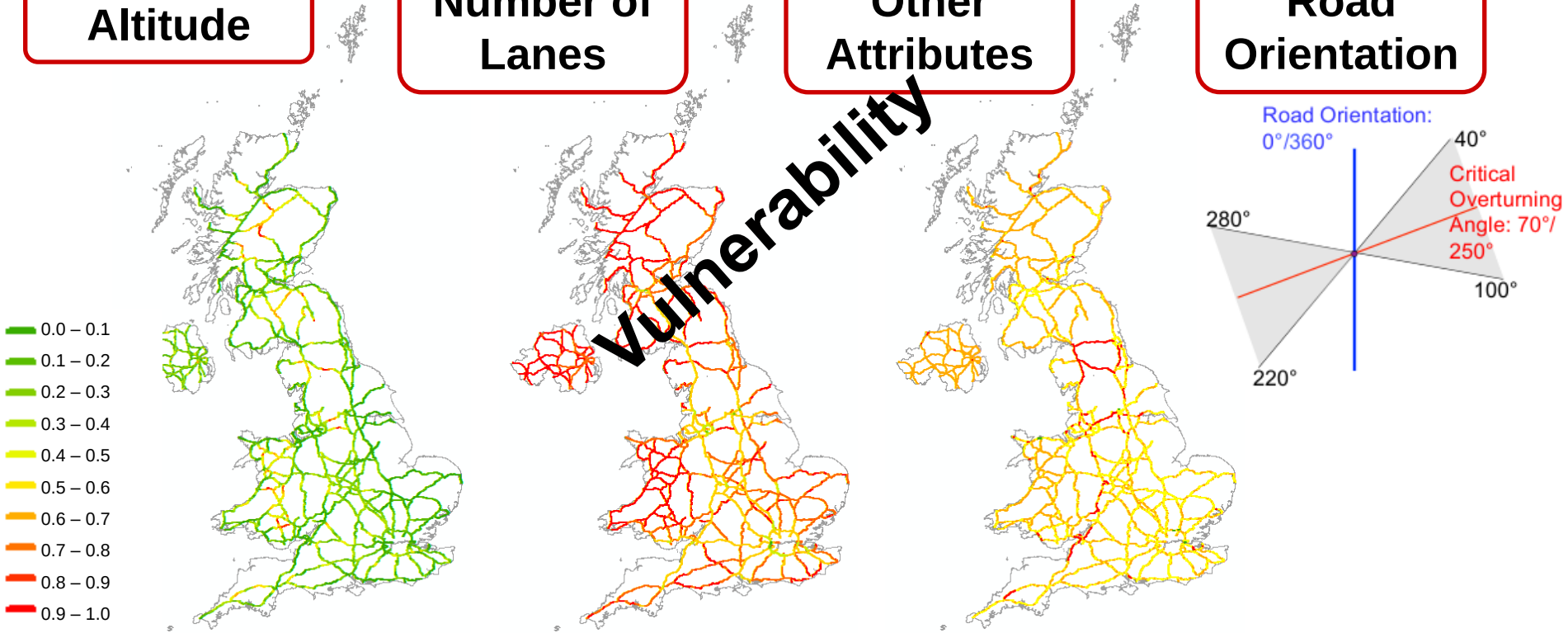
Risk Algorithm: Vehicle OverTurning Model

Altitude

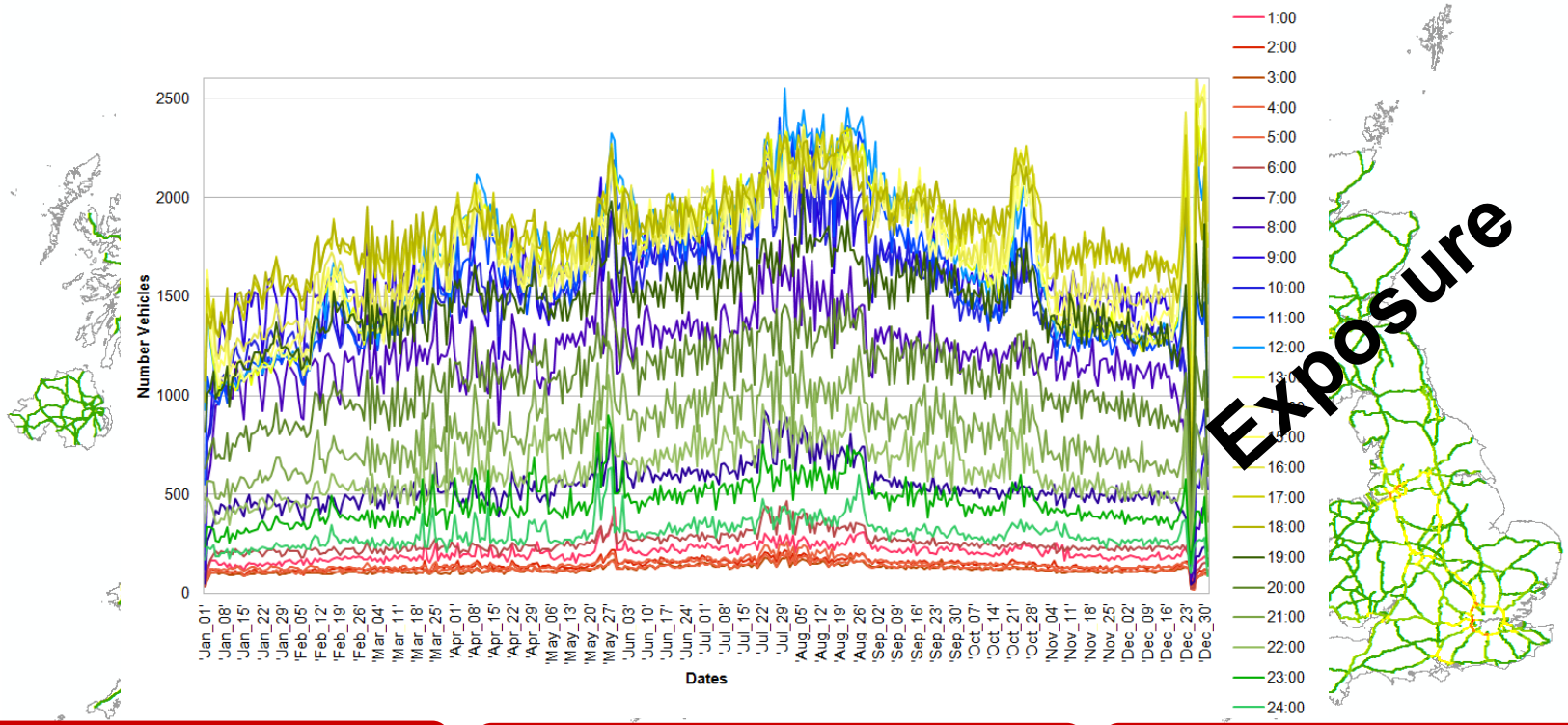
Number of Lanes

Other Attributes

Road Orientation



Risk Algorithm: Vehicle OverTurning Model



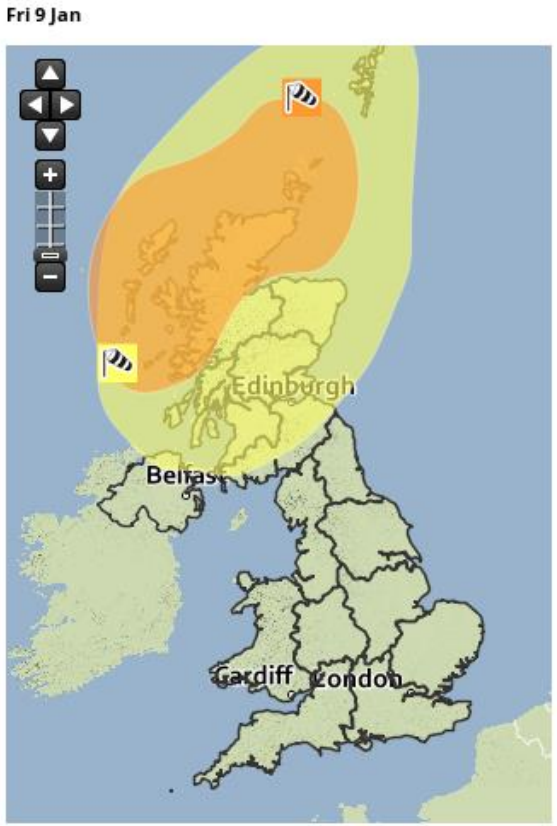
Number UHGVs

Number UHGVs + LGVS

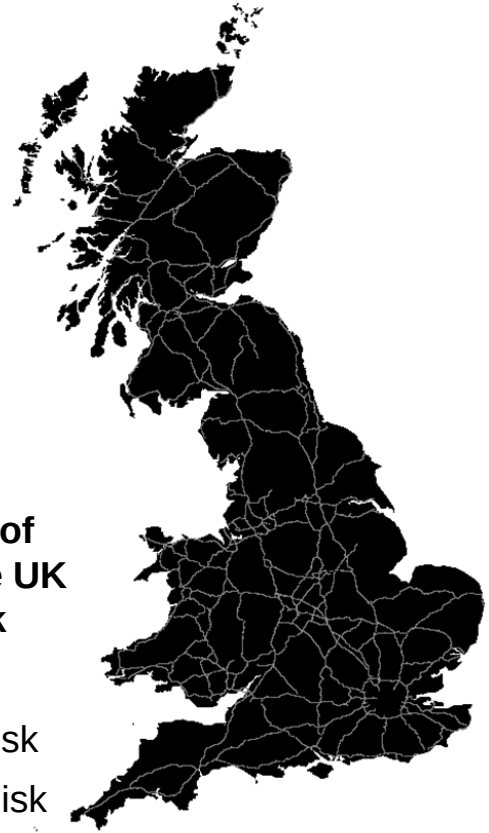
Number all Vehicles

NSWWS Wind Warnings Morning 8th January 2015

8th January 2015 19:00



National Severe Weather Warning Service (NSWWS) wind warning compared to the Vehicle OverTurning model

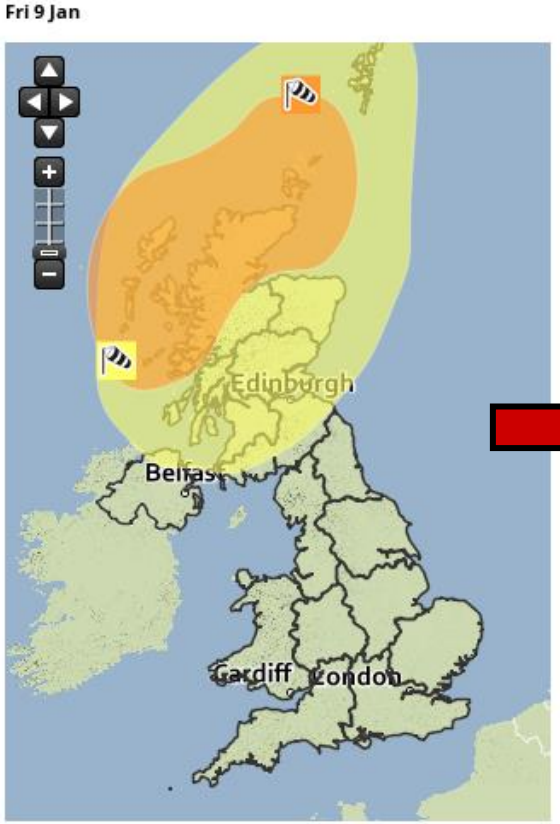


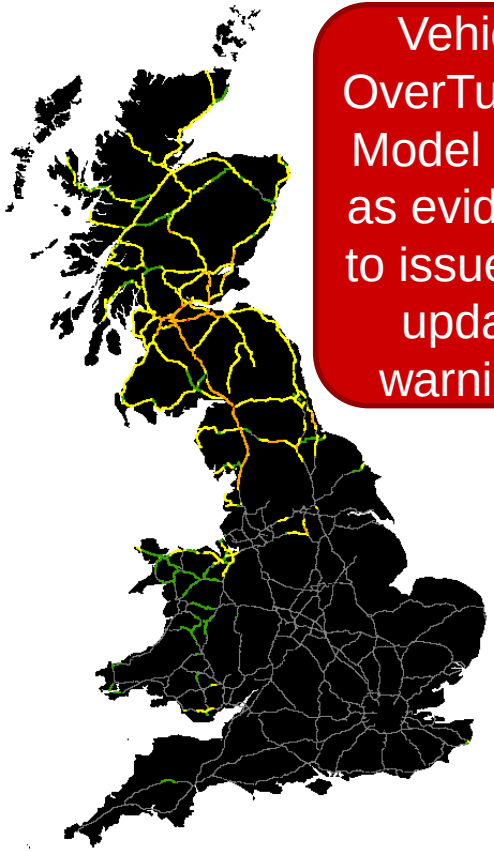
Maximum Risk of Disruption on the UK Road Network

- Low Risk
- Low - Medium Risk
- Medium - High Risk
- High Risk

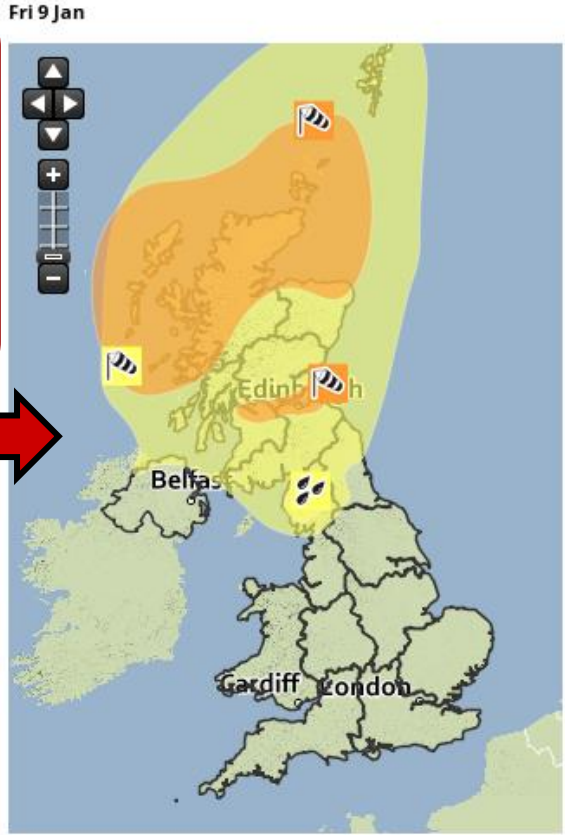
T+22 Model run: 7th January 21Z

Morning 8th January 2015





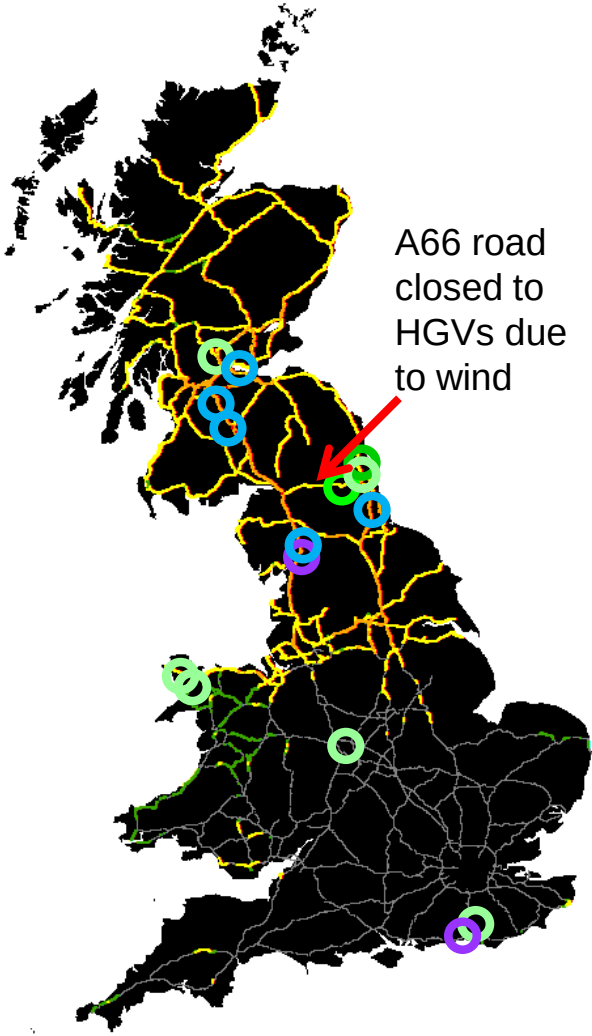
Vehicle OverTurning Model used as evidence to issue and update warnings

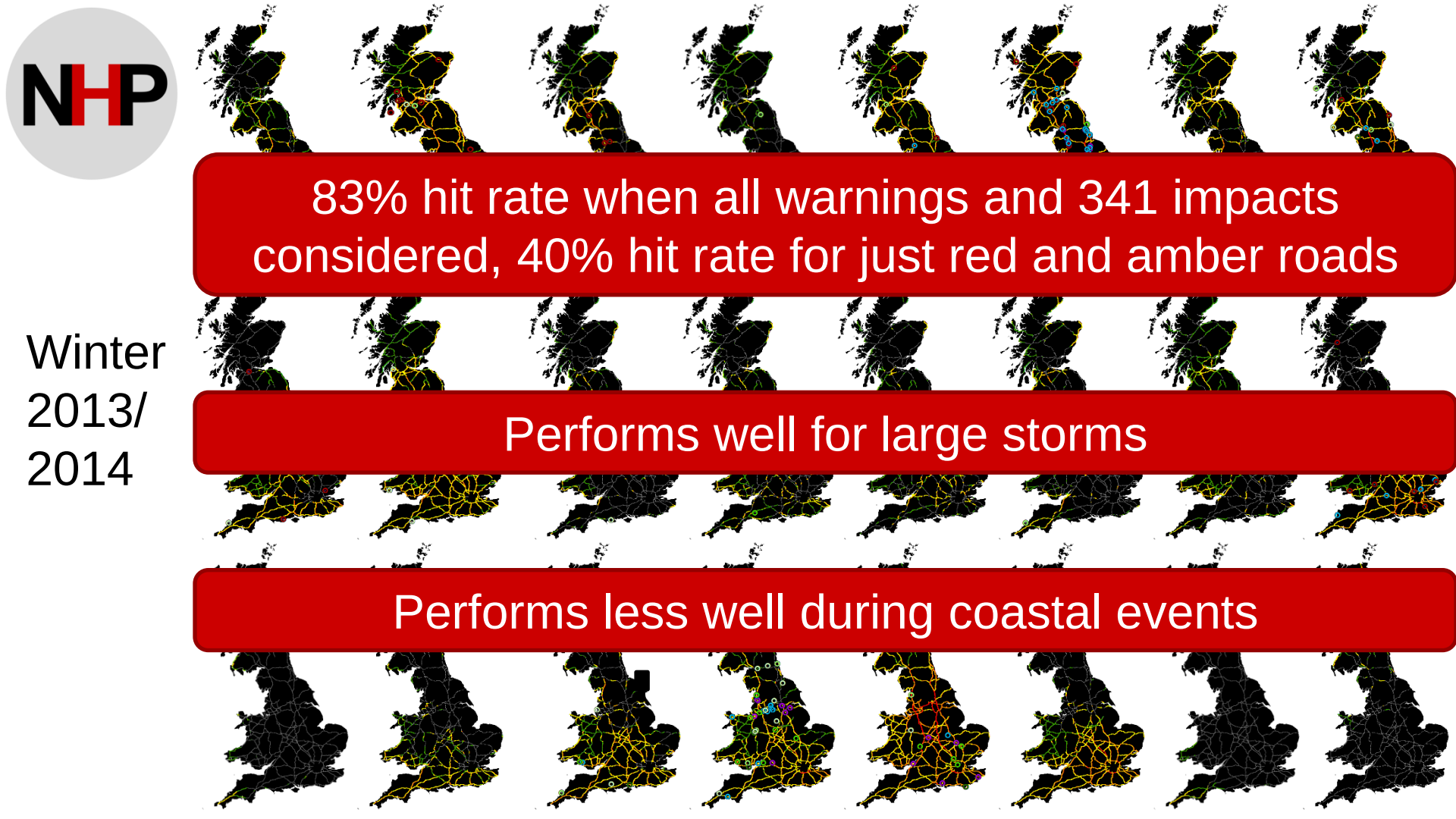


VOT Verification

8th/9th January 2015

Multiple impact events reported including a van blown over in the amber warning in the Central Belt, Scotland
Model verifies well




NHP
83% hit rate when all warnings and 341 impacts considered, 40% hit rate for just red and amber roads
Winter 2013/ 2014
Performs well for large storms
Performs less well during coastal events

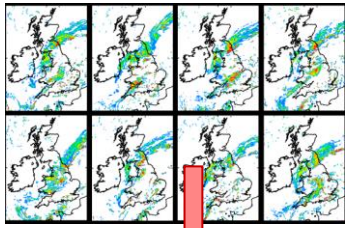
Surface Water Flooding Hazard Impact Model

www.naturalhazardspartnership.org.uk/science/hims/surface-water-flooding

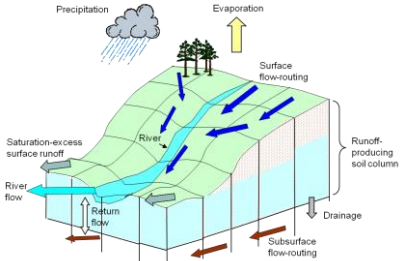
Surface Water Flooding Hazard Impact Model Overview

SWF HIM innovation builds on existing models, data and tools

Rainfall ensembles (MOGREPS-UK)



Grid-to-Grid Hydrology

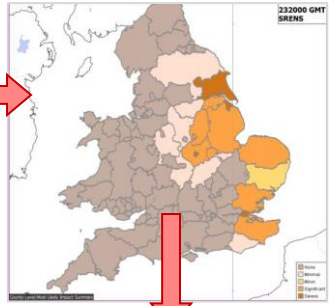


SWF Hazard Footprint

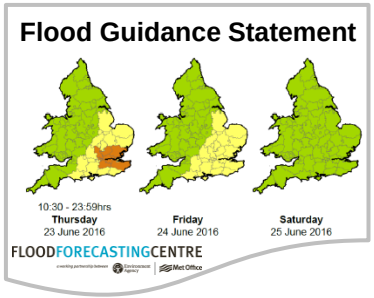
SWF HIM

Real-time SWF risk outputs

Visual Weather



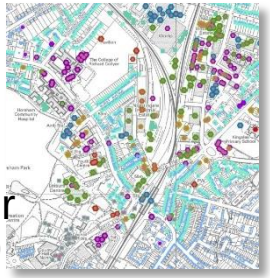
Dissemination



Impact Library

Updated Flood Map for Surface Water

National Receptor Database (NRD)



National Population Database (NPD)

Impact Library Construction

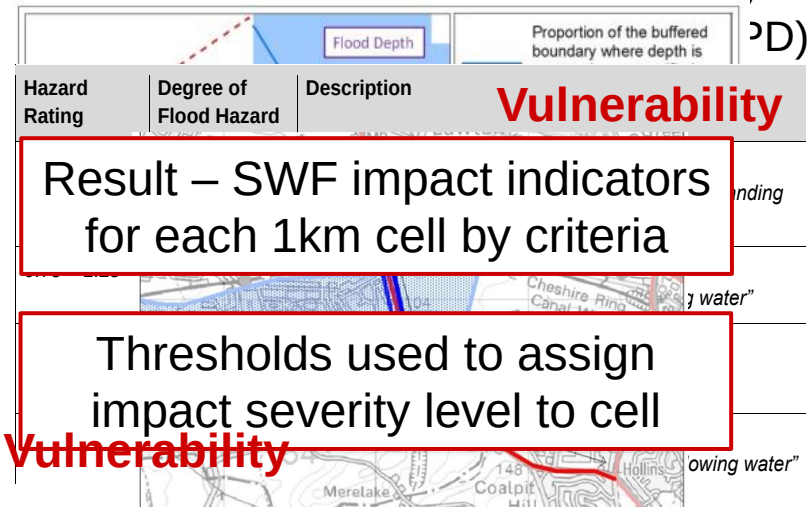
Hazard

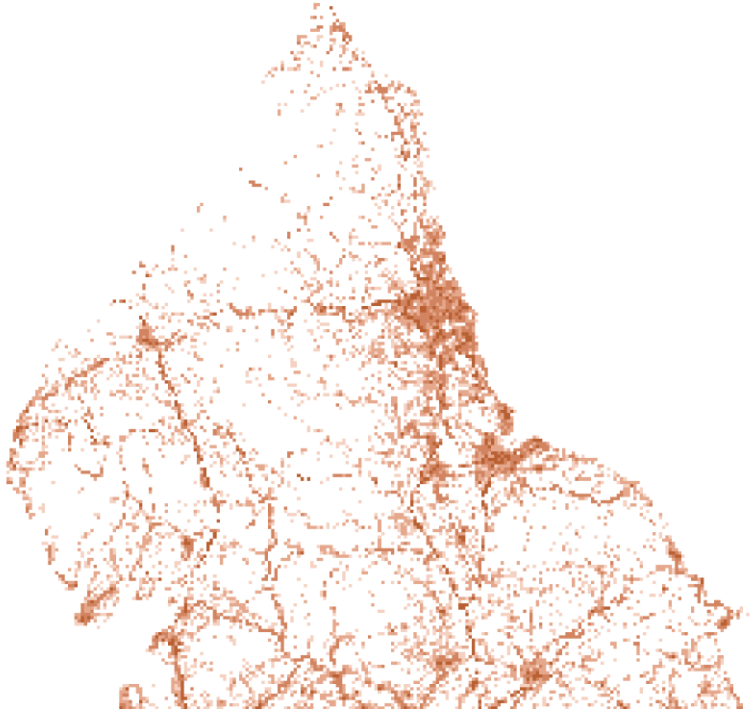
EA Updated Flood Map for Surface Water (uFMfSW)

Exposure

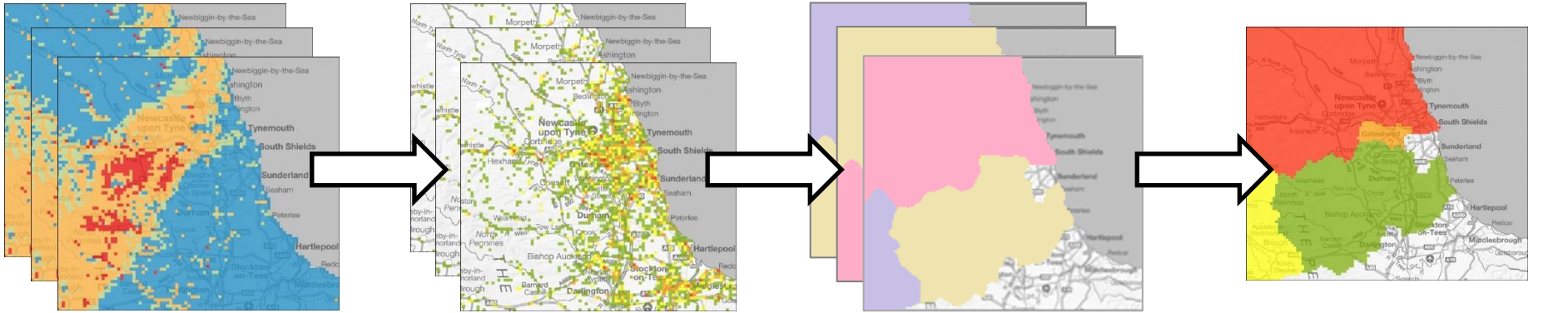
OS MasterMap Building Information

EA National Receptor Database (NRD)

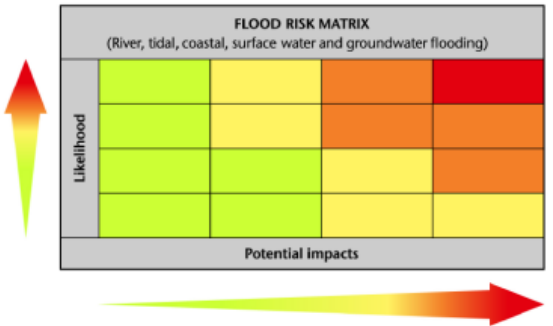




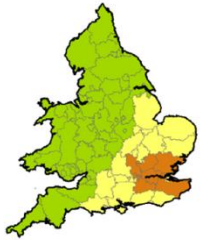
Surface Water Flooding HIM Risk Outputs



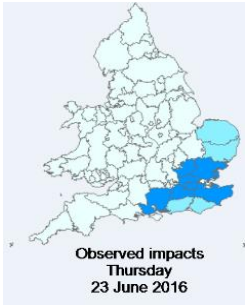
- Regional impact summary for each ensemble member
- Combine impact and likelihood to calculate risk
- Summarises over time, space & uncertainty



Trial case study: 23rd June 2016

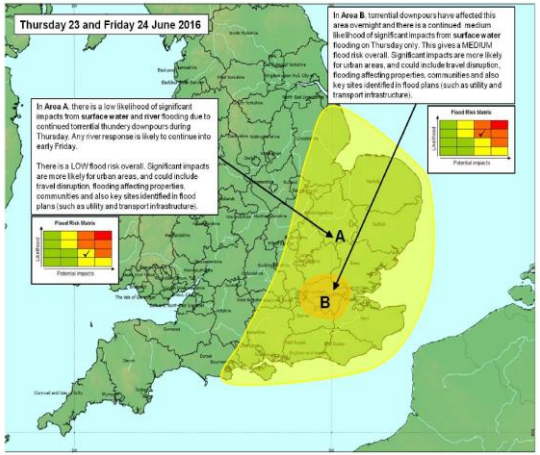


10:30 - 23:59hrs
Thursday
23 June 2016

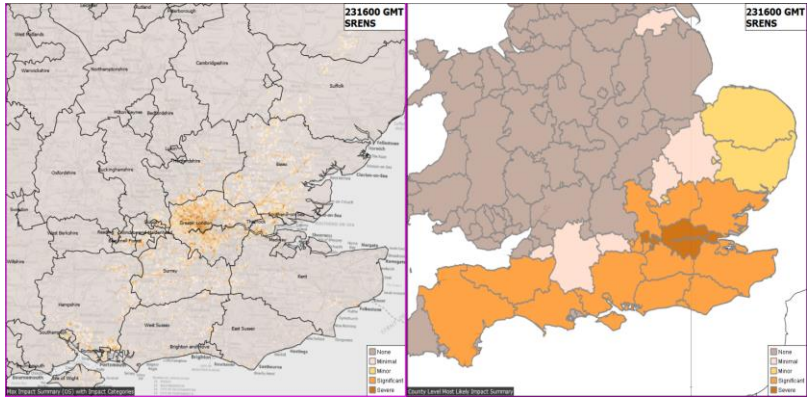


Observed impacts
Thursday
23 June 2016

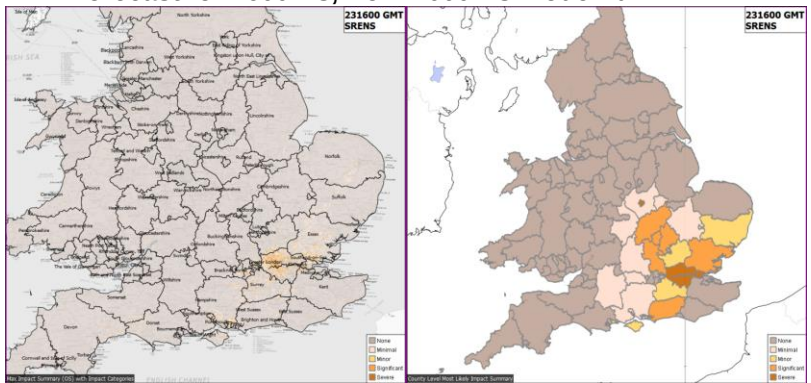
Specific areas of concern



Forecast for 1600hrs, from 0400hrs model run



Forecast for 1600hrs, from 1000hrs model run



Gtr London

23-Jun-2016 16:00:00

Threshold = 15 sq. km.

Impact	Members
None	15
Minimal	1
Minor	0
Significant	4
Severe	4

[SRE_1000_1]

Slough

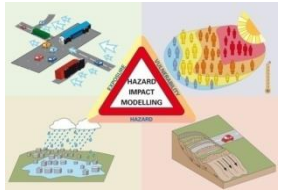
23-Jun-2016 16:00:00

Threshold = 0 sq. km.

Impact	Members
None	20
Minimal	0
Minor	0
Significant	0
Severe	4

[SRE_1000_1]

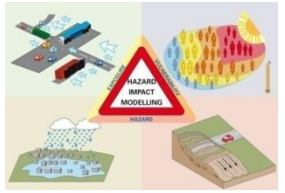
Benefits of HIMs



Real-time tools which:

- Aid decision making for warnings/alerts
- Improved preparedness before event
- Improve understanding of natural hazard impacts
- Encourage cross-organisational collaboration to create and visualise

HIM Challenges



HIM development presents challenges that need to be addressed:

- **Underpinning Science**
- **Available Data**
- **Timeliness**
- **Communication of Results**

Hazard Impact Framework (HIF)

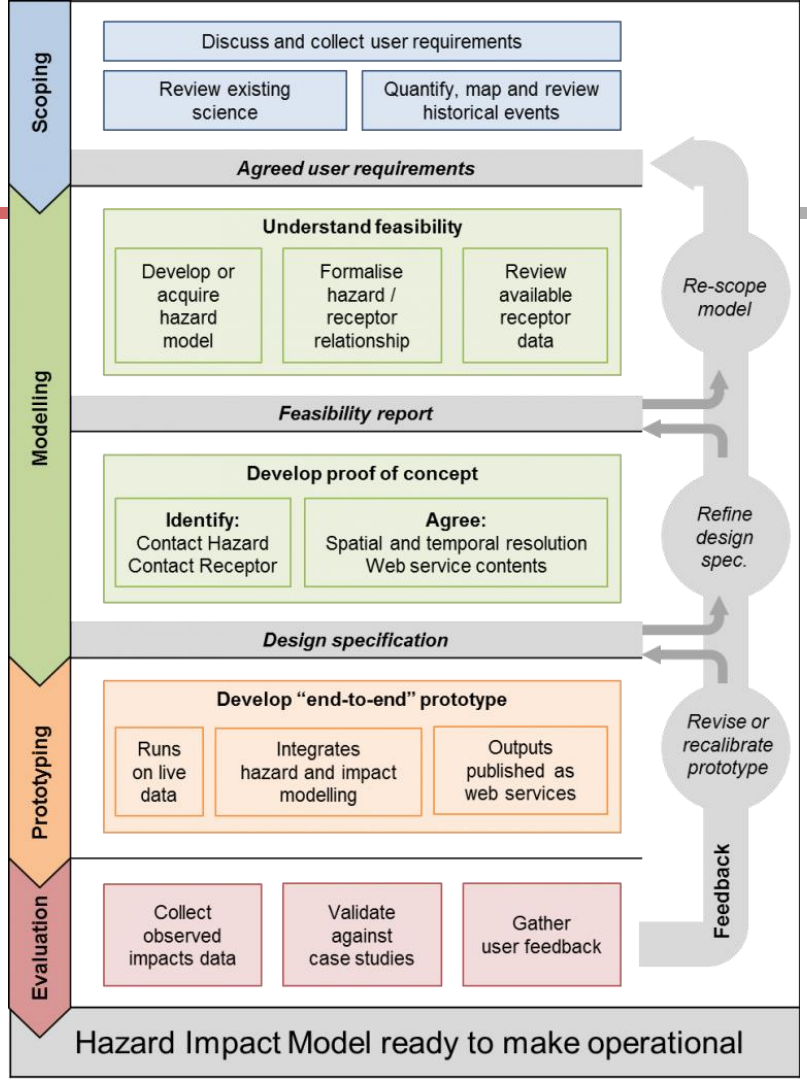
www.naturalhazardspartnership.org.uk/hazard-impact-framework

Hazard Impact Framework

The Hazard Impact Framework (HIF) provides the NHP with a **common and consistent approach** to modelling and forecasting natural hazard impacts. Specifically, the HIF is a source of **definitions** and **common concepts** in impact modelling. It provides a standard series of **guidelines** and, where necessary, stricter **protocols** for **building and developing HIMs.**

Natural Hazards Partnership Hazard Impact Framework: First Edition

Natural Hazards PARTNERSHIP



Hazard Impact Framework

- Allows for model interoperability
- Multi-hazard impact assessment
- Written with the aim that it can be applied to all hazards, timescales, resolutions, assets...
- Working document which will evolve as knowledge and experience is gained

Natural Hazards Partnership
Future Work

- New NHP **Operating Plan 2017-2020** – available on the website soon
- Work on **multi-hazards** including concurrent and cascading hazards using HIF
- **Longer term impacts** – monthly timescales
- Impact model **verification** using social media impact reports
- **New Hazard Impact Models**
  - Scoping snow and ice
  - Potential future HIMs: air quality, heat and cold, groundwater, lightning

Journal Paper

The Natural Hazards Partnership: a public-sector collaboration across the UK for natural hazard disaster risk reduction

Rebecca Hemingway[1,*] and Oliver Gunawan[2]

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*Corresponding author
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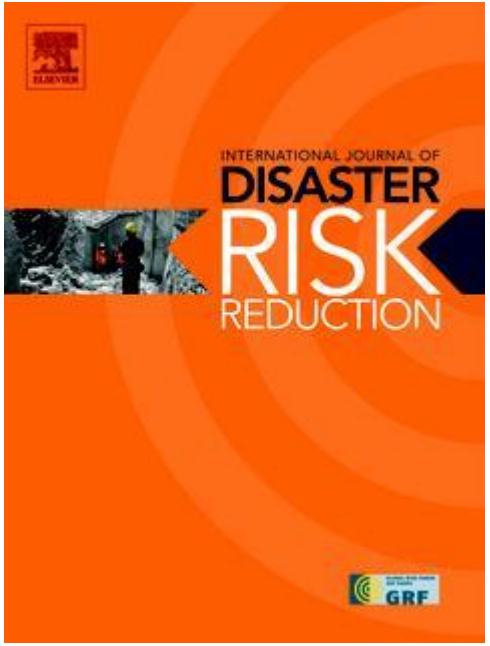

Partnerships underpin everything we do…

We work together with multiple organisations and initiatives

ResilienceDirect

Environmental Science to Services Partnership

British Geological Survey · Centre for Ecology & Hydrology · Environment Agency · Met Office · NERC Science of the Environment · Ordnance Survey

Space for Smarter Government Programme

BERG

BUSINESS IN THE COMMUNITY

UKADR United Kingdom Alliance for Disaster Research

thrivespring
Get connected. Get organised. Get prepared.

Summary

- **Natural Hazards Partnership** is a successful partnership, by working together we can more effectively provide impact based advice
- **Hazard Impact Models** have been shown to aid decision making in the issuing of impact-based warnings
- **Hazard Impact Framework** facilitates HIMs being developed in a consistent way and allows for multi-hazard impact analysis
- **Communication** is vitally important at all stages

Thank you!

Learn more on our website

www.naturalhazardspartnership.org.uk