WWRP Warning Value Chain Project

Warning Chain Database questionnaire

I. Purpose

Please use this form to record as much information as possible on the end-to-end warning chain for a hazardous weather event. This information will:

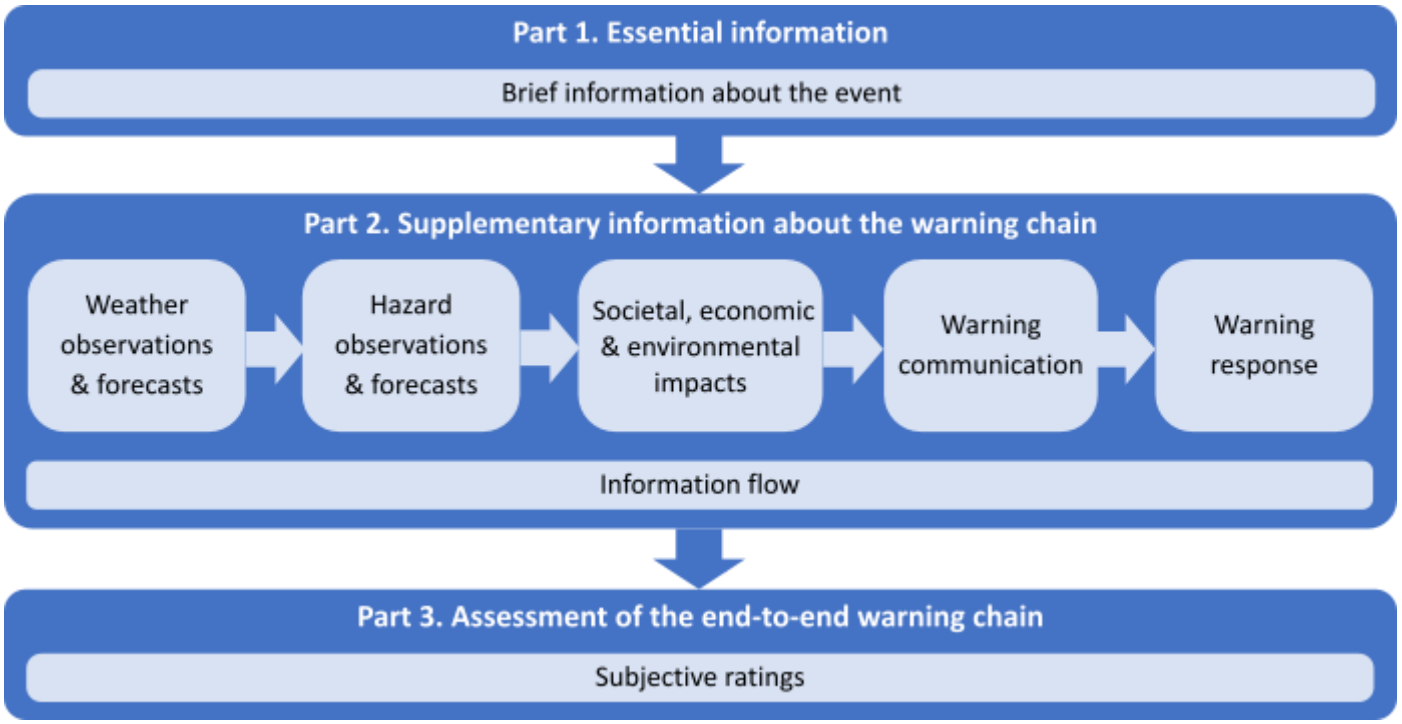
- add to a global database of hazardous weather events with rich information covering the many components of the warning value chain
- enable case studies and cross-cutting analysis of end-to-end warning value chains, from simple to complex, to understand effective practices.

The warning value chain database tries not to duplicate data collected in databases for other purposes. This template provides for a comprehensive picture of the information flow, decision making and response during a high impact weather event.

More information about the WWRP Warning Value Chain Project can be found at http://hiweather.net/Lists/130.html.

II. Structure and format

The form consists of three main parts.



Part 1. The **essential information table** requests brief facts about a particular event, such as what happened, when, where, impacts and responses. This information will help users to filter events. Please provide numerical and short text entries. Links to other databases and catalogues (e.g., ECMWF Severe Event Catalogue, EM-DAT, DesInventar, etc.) about this event should be provided.

Part 2. The second part requests **supplementary information** about different stages in the warning value chain. This more detailed information and analysis about the weather, the hazards, the impacts, the

warning communication and warning response will help users understand what was unique about the warning chain for this event. The guidelines are just suggestions, they are not exhaustive.
Information here might include:

- Graphics (for example, forecast charts, reanalysis maps, warning graphics, photos of impacts, etc.)
- Videos (for example, from social media, weather service outlooks, etc.)
- Free-form text (for example, description of meteorology, selected extracts from reports, data analysis, tables, etc.)
- Links (e.g., to other databases/catalogues, external reports, media, etc.)

Note:

⇒ Part 2 is optional, provide what you feel able to.

⇒ Each section has an "additional analysis" where you can add further information not covered by the items in the template.

⇒ Try to keep your entries brief and include references and links (URLs) to where additional information can be found.

⇒ Many people may contribute information on this event. Where you disagree try to provide evidence to support your position.

⇒ You can acknowledge contributors that provided you with information for the template at the end of the template before Annex 1. This is optional.

Part 3. The subjective assessment asks contributors to rate the effectiveness of the individual elements of the end-to-end warning chain, and its overall effectiveness, on a scale of 1 (poor) to 5 (excellent). This may assist users of the database in choosing cases and performing meta-analysis (recognising the large variability in contributor' judgments).

III. Tips

- Detailed instructions, explanations and examples about the data asked for are provided in the dedicated Guidance document (link to document on VC webpage).
- The Value Chain Glossary provides a common terminology. Use the names of hazard types listed in *Annex 1* of the template or this guide.
- A series of prompts (i) in this template provide some quick information to assist with entering the required data. Simply put your cursor over the information symbol i and text should pop up next to it (ignore the “Ctrl+click to follow link” instruction). *Note, that this feature is only available in the Microsoft Word App, not in the SharePoint or Google Drive browser page.* Consult the Guidance document instead if this feature does not work for you.
- It is not anticipated that a single person can fill in the entire template. Rather, we encourage to share the template with colleagues who can provide information.
- See HERE for a worked example of the template.

Part 1. Essential information

Editors (Name & Institute)	*Brian Golding, Met Office*

HIGH IMPACT WEATHER EVENT	
Unique identifier i	
Name of event	*Storm Filomena*
When did it happen i?	7-15 January 2021
Where did it happen i?	Spain & Portugal
WHAT HAPPENED – WEATHER, HAZARDS, IMPACTS, WARNINGS, RESPONSES	
Weather event type/system that caused hazards i *Refer to Annex 1*	*Extratropical Cyclone*
If possible, provide more detail about weather observations & forecasts *(link to page)*	
Hazards that caused the main impacts i *Refer to Annex* 1	Snow, Cold Wave
Classify hazard in regard to the location's climatology i	*Extreme (worst since 1971)*
If possible, provide more detail about hazard observations and forecasts *(link to page)*	
What were the main direct impacts i?	*Loss of all surface transport, schools closed, no waste collection, damage to trees and buildings, fracture from falls on ice.*
Economic damage in USD i	*USD 2.2bn*
Fatalities	*5*
If possible, provide more detail about impact observations and forecast *(link to page)*	
Main warnings issued i	3-day warning of extreme snow - 15cm in Madrid
Who issued the warnings? i	*AEMET*
If possible, provide more detail about the warnings and communication *(link to page)*	
Main responses to warnings i	*Pre-emptive closing of airport/transport?*
If possible, provide more detail about responses to warnings *(link to page)*	
Links to other databases *(ECMWF catalogue of severe events, WMO CHE, DesInventar, EM-DAT, GLIDE, etc.)*	ECMWF newsletter (not in the events catalogue) https://www.ecmwf.int/en/newsletter/167/news/unusual-snowfall-madrid-january

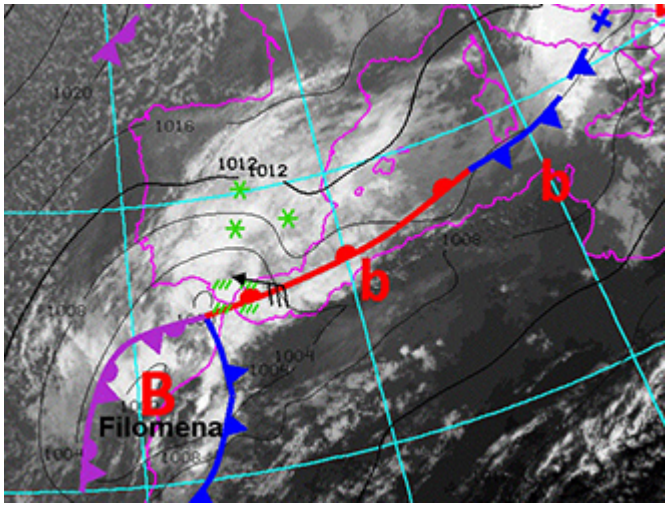
Part 2a. Supplementary information about weather

Wherever possible, please include references to information you provide!

Editors (Name & Institute): Brian Golding (Met Office)

Meteorological overview iStorm Filomena formed as a low pressure centre along a frontal boundary over the Canary Islands on 7 January. The system then moved slowly north-eastwards, crossing the Iberian Peninsula between 8–10 January. The storm's slow movement contributed to the duration and severity of snowfall across Spain and Portugal. During the time of Filomena's passage over the Iberian Peninsula, a powerful high-pressure system, named Anticyclone Antje by the Free University of Berlin, was centred over the United Kingdom,bringing cold air from the Arctic across the British Isles and down into the vicinity of StormFilomena. This cold air became entrained into the leading edge of Filomena as it pushed north-eastwards against the southern edge of the area of high pressure, leading to heavy snowfall. After emerging into the Mediterranean Sea, Filomena accelerated eastwards away from the area of high pressure, losing its supply of cold air in the process. (Wikipedia)

Weather observations and analyses i



(AEMET frontal analysis copied from ECMWF newsletter)

How did the observed weather relate to climatology and/or previous extreme events? i Heaviest snow since 1971, Coldest “in 100 years”

Special/non-traditional observational data used in the weather forecast or assimilated into NWP i None known

Weather models

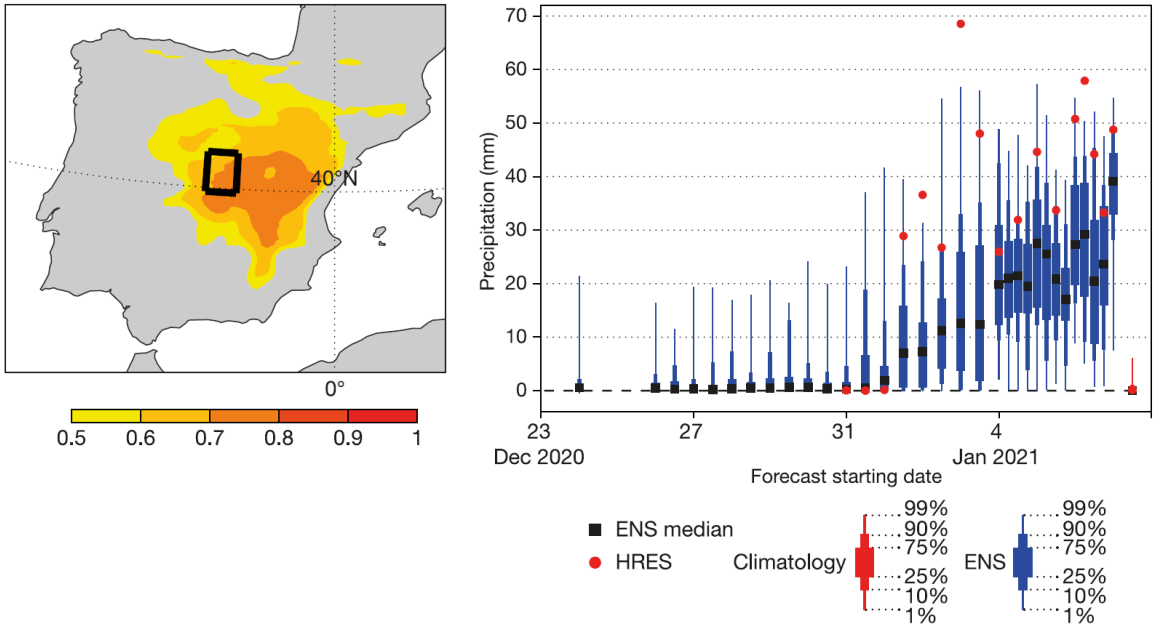
(Info on operational NWP systems: http://wgne.meteoinfo.ru/nwp-systems-wgne-table/wgne-table/)

Name	Horizontal resolution	Ensemble size	Forecast length
ECMWF HIRes and ensemble			

Post-processing/calibration applied to weather model output i

Deterministic weather forecast outputs and examples i

Ensemble/probabilistic weather forecast outputs and examples i Left image is EFI from 00UTC 3/1/2021. Right image is evolution of 72hr precipitation forecast for 7 - 9 January, as indicated in the key.



(copied from ECMWF newsletter)

Interpretation/guidance for forecast users i The EFI classified the event area at 0.7-0.8 from 3rd January. AEMET forecast guidance from this time referred to the exceptional nature of the event.

What was the level of agreement between the different forecasts? i The HIRes gave significantly higher precipitation totals than the ensemble median.

How reliable and accurate were weather forecasts? i Movement of the cyclone accurate at 4 days ahead. Amount of snow extreme, but not as much as observed. Lowest temperatures extreme but not as low as occurred.

When was the potential event first detected in the models? i Late December (transition to negative NAO), 1st January (specific event - ECMWF Hires snowfall), 4th January (median of ECMWF ensemble snowfall)

Additional analysis i

Successes/issues/challenges experienced? i

Part 2b. Supplementary information about hazards

Wherever possible, please include references to information you provide!

Editors (Name & Institute): Brian Golding (Met Office)

Brief overview of the hazard event(s) i Near the coasts, wind gusts of up to 80 km/h(50 mph) occurred as Filomena made landfall on 7 January, as well as 25–50 mm of rain in southern areas of Spain and Portugal which caused some flash flooding. Further inland and in higher elevations, snowfall of up to 60 cm was recorded. In the Sierra Nevada mountains of southern Spain, wind gusts of up to 121 km/h accompanied the large snow totals, leading to blizzard conditions.

Hazard observations and analyses i On 9 January, AEMET reported between 50–60 cm of accumulated snow from its weather stations within Madrid.

How did the hazard(s) relate to climatology? i The severity of the event was unmatched by any previous snowfall in the Spanish capital since at least 1971.

How was the hazard(s) made worse by pre-existing conditions? i The main exacerbating factor was COVID.

Observational data used in the hazard forecast or assimilated into the hazard model i None known - assimilation of snow cover might have had an effect?

Hazard prediction models/tools i AEMET have access to a regional model, but I have not seen any outputs from it.

Name	Resolution	Ensemble size	Forecast length
ECMWF HIRes & ensembles			

Deterministic hazard forecast outputs and examples i The HIRes gave significantly more accurate snowfall predictions than the ensemble median, at all lead times.

Ensemble/probabilistic hazard forecast outputs and examples i

How reliable and accurate were the hazard forecasts? i

What was the trigger used to classify the event as hazardous and start the warning process? i Naming of the storm, probably based on ECMWF precipitation prediction / EFI?

Additional analysis i

Successes/issues/challenges experienced? i

Part 2c. Supplementary information about impacts

Wherever possible, please include references to information you provide!

Editors (Name & Institute): Brian Golding (Met Office)

Brief overview of the impact(s) i[13]
Due to the unprecedented amount of snowfall, some unsuspecting motorists were trapped on the roads for hours. As Filomena began to move into the area, snow began to fall in Madrid on 7 January. This was followed by 30 hours of continuous snowfall on 8–9 January. The EMT's bus lines, the commuter rail Cercanías as well as Madrid-Barajas airport all stopped operating due to heavy snowfall. The Metro de Madrid became the only available public transportation system, staying open 24 hours for only the second time in its history after the 2017 Madrid World Pride event. During these events in Madrid, winter sports were practiced in the city. The slopes of the Cerro del Tío Pío in Vallecas were used as snowboarding runs. The Military Emergencies Unit (UME) contributed to clear up accesses to hospitals — the event took place amid the third wave of the deadly COVID-19 pandemic and the connected vaccination effort—and the Madrid–Barajas Airport lanes. Five people were killed in Spain during the passage of Filomena.

Observed health impacts i By 9 January, two homeless people had died from the effects of cold weather, one in Madrid and one in Calatayud. Two more deaths occurred due to flooding in Málaga. On 16 January, a fifth dead body was found underlying snow in the Arganzuela district of Madrid. Over 2000 hospitalised with fractures from falling on ice.

Observed property and business impacts i The roof of "La Nevera", in the IES Ramiro de Maeztu school, the traditional home of the CB Estudiantes youth system, collapsed due to the weight of snow.

Observed critical infrastructure damage and service disruption i Roads closed - 1500 motorists rescued from stranded vehicles. Airport closed. All surface public transport suspended - only the metro continued to run. Schools closed until 20th January.

Environmental damage observed i Early estimates showed that around 150,000 trees in the city (18.5% out of the 800,000 registered trees) were damaged or had collapsed due to the snow. Later assessments by the Madrid Town Hall gave figures of 70% of trees in historical parks, 15% of trees in singular parks and an additional 450,000 trees in forest parks being damaged by the storm. Conifers and Mediterranean evergreen trees were particularly affected.

Impact prediction models/tools i

Name	Method
None known	

Impact forecast outputs and examples i No evidence of any predictions - except that it will be disruptive.

Comparison of predicted and actual impacts i **-**

Informal rules/tools used to identify impacts i -

Who and what were exposed to the hazards, when, for how long and why? i Homeless people were most exposed - primarily to the cold. The general public were exposed to the icy surface for a week or more, due to lack of clearance.

Out of those exposed, who and what were vulnerable to the hazards and why? i Primary vulnerability was from falls - leading to fractures in the most vulnerable.

Additional analysis i

Successes/issues/challenges experienced? i

Part 2d. Supplementary information about warning communication

Wherever possible, please include references to information you provide!

Editors (Name & Institute): Brian Golding (Met Office)

Brief overview of the communication "story" i The storm was named on 5th January as part of the early warning story. By the time of its arrival the warning had been upgraded to a "red alert".

What information was provided to emergency responders, government and other stakeholders about the hazard and its possible impact, and by whom? i All warnings were issued by AEMET. Information to specific sectors not known.

Public warnings in detail i

Warning name	Warning lead time	Issued by	Warning area i	Type of warning i	Did it include safety advice?	Scaled i	Channel i	Warning frequency
Filomena	4 days	AEMET	Much of Spain	Named Storm	No			

Warning outputs and examples

Was uncertainty included in the warning? If so, how? i Warning issued on January 5th indicated 'high degree of uncertainty'

Were communication systems in place and operating effectively? No evidence of a failure of communications with the public. Links between AEMET and city emergency managers appear to have been limited. However, once the snow was on the ground, weather forecast updates were of less relevance.

Were warning messages received and understood by the public? How did you know? Range of internet sources indicate warnings were widely known.

Were the needs of specific communities and populations addressed? If so, how? No evidence that they were.

Additional analysis i

Communication success/issues/challenges experienced i

Part 2e. Supplementary information about responses to warnings

Wherever possible, please include references to information you provide!

Editors (Name & Institute): Brian Golding (Met Office)

Brief overview of the response to the hazard by emergency services and other partners i No evidence of response to warnings. Response to snow hazard was to close down transport and rescue stranded people. Limited route clearance was undertaken by the military, but most roads remained closed for a week.

What were the main response actions by the public to the warnings? i Initially the main response was to go out and enjoy winter sports. Eventually the public undertook clearance work themselves.

Institutional responses i

Response actions	Taken by whom	When taken	On the basis of what information?	Benefit (if any)	Cost

How did the overall response to this event compare to similar previous events? i Not known. Last relevant event was 2009. Last comparable event was 1971.

How knowledgeable was the community about the hazard? Very low

Were disaster preparedness and response plans in place and used? None apparent.

What capacity did the community have to respond to warnings? None apparent

Additional analysis i

Success/issues/challenges experienced i

Part 2f. Analysis of the warning chain

Information flow through the warning chain

Warning chain	Was all necessary input information available? (yes/no)	If no, what input information was missing?	Who should have provided the missing information?
Weather forecast	Yes		
Hazard forecast	Yes		
Impacts forecast	No	The hazards were slightly underestimated.	
Warning communication	No	Lack of impact information	
Warning response	No	Lack of impact information. Lack of response suggestions.	City authorities?

Tools and operational workflows for sharing information between partners

How were social media data used in the warning chain? i Not known

Evidence that warning chain was effective in reducing fatalities, injuries, damage, and/or disruption? Probably not.

What were the strongest links in the warning chain? i The weather and hazard, and their communication were strong.

What were the weakest links in the warning chain? i The indirect and delayed impacts seem to have been missed.

What procedures were used to identify lessons learned from the event? i None known.

If known, how did lessons learnt from previous events contribute to greater warning success for this event? The warning referred to a previous event of 2009, but there appears to be no reference to any changes made since then. In the event it was far worse than that.

Additional analysis

Part 3. Assessment of the end-to-end warning chain

Assessor (Name & Institute) (optional): Brian Golding (Met Office)
Profession:
Please rate your level of expertise on a scale of 1 (no expertise) to 5 (established expert) for:

Weather:	5
Hazard:	5
Impact:	4
Warning/communication:	3
Response:	2
High-impact weather event evaluation:	4

HOW SUCCESSFUL WERE THE FORECASTS, WARNINGS AND RESPONSES?

How well was the event observed? *Scale of 1 (poor) to 5 (excellent) 4*
Reason for this rating i At least for the Madrid area, there are good observations of the meteorological hazard and good press reporting of the impacts. Information on institutional responses is less good.

How well was the weather forecast? *Scale of 1 (poor) to 5 (excellent) 4*
Reason for this rating i The weather system was well forecast prior to formation. Short range forecasts had a low bias in the precipitation.

How well were the hazards forecast? *Scale of 1 (poor) to 5 (excellent) 4*
Reason for this rating i The amount of snow and the temperatures were well forecast, though slightly biased to less extreme values. The EFI was in the highest category.

How well were the impacts predicted? *Scale of 1 (poor) to 5 (excellent) 2*
Reason for this rating i Without any formal modelling, the warnings indicated that there would be serious disruption. However, the indirect impacts of prolonged snow/ice in Madrid seem not to have been realised.

How well were warnings communicated? *Scale of 1 (poor) to 5 (excellent) 4/5*
Reason for this rating i The exceptional nature of the event was well communicated at an early stage and was picked up by the press (and presumably other media). I do now have evidence to judge whether appropriate information reached everyone who needed to know.

How well were the warnings used? *Scale of 1 (poor) to 5 (excellent) 1*
Reason for this rating i There seems little evidence of any response to the warnings. This appears to be due to there being no response plan or capability for this type of hazard.

How well did the entire warning chain perform overall? *Scale of 1 (poor) to 5 (excellent) 1*

Thank you very much for contributing to the WWRP Warning Value Chain Project database!

Acknowledgements (e.g., information providers) i

Annex 1: *Weather system and hazard types based on pre-defined hazards in the Sendai Framework Monitor*

a) Weather system types

- Blizzard
- Derecho
- Tornado
- High pressure system
- Extra-tropical storm
- Tropical cyclone
- Convective storm
- Extreme temperature
- Cyclone surge
- Fog
- Cyclonic rain
- Rain
- Cyclonic wind
- Snow

b) Hazard types

- Coastal erosion
- Fog
- Lightning
- Coastal flood
- Freak waves
- Riverine flood
- Cold wave
- Freeze
- Snow
- Dust
- Frost
- wind
- Fire
- Hail
- Wave action
- Flash flood
- Heat wave
- Wildfire
- Flood
- Ice

Weather (system) types		**Hazard types**		
Type	*Sub-type*	*Type*	*Sub-type I*	*Sub-type II*
Tropical storm/cyclone		Rain	Flood	Riverine flood, coastal flood, flash flood
		Wind	Wave action/ storm surge/ freak waves	Coastal erosion
			Dust	Dust
Convective storm	Tornado	Lightning	Fire	Urban fire, wildfire
	Derecho	Hail		
Extratropical storm	Cyclonic storm			
	Blizzard	Snow	Avalanche	
			Snow drift	

High pressure system	Extreme temperatures	Cold wave	Freeze, frost, ice
		Heat wave	
Fog	Fog		