NZ Canterbury Flooding May 2021

Template for high-impact weather event reporting

I. Purpose

This template is designed by the WWRP HIWeather Value Chain project to record the entire end-to-end warning chain for high-impact weather events. The template has two main purposes:

- To provide an accessible means to populate a living database of hazardous weather events with rich information covering (as much as possible) the components of the warning value chain
- To record information for analysis and advice on best practice warning value chains (from simple to complex) in the database

II. Structure

The template consists of two main parts.

The first is a **'Quick-look summary' table** that contains minimum information about a particular event with an overview of what happened, when, where and how successful predictions and warnings were.

Commented [1]: Sometimes we say predictions and sometimes we say forecasts. Is that ok?

The second part is divided into six sections. The first five are organised according to the different stages in the warning value chain and asks for more **detailed information and analysis** about:

1) weather forecast and observations (e.g., analysis charts, ensemble forecasts),
2) hazard forecast and observations (e.g., analysis, detection tools),
3) impacts (e.g., health and infrastructure impacts, predictions),
4) warning communication (e.g., warnings issued, channels used), and
5) warning response/decision (e.g., evacuation, response of communities and emergency management)

The sixth/last section

6) analysis of the end-to-end warning chain

evaluates the flow of information along the warning chain and its successfulness (e.g., were forecast timely enough for decision-making, weak links in the chain).

III. Format

The 'Quick-look summary' table is intended to be concise with factual description and essential information.

The Value Chain Glossary provides a common terminology. Use the names of hazard types listed in *Annex 2*.

Part 1 accepts numerical and short text entries.

Part 2 accepts a wide variety of input information to reflect broadest details of the event. Such entries can be but are not limited to:

- Graphics (e.g., forecast charts, reanalysis maps, warning graphics, images of impacts, etc)
- Videos (e.g., from social media, weather service outlooks, etc)
- Free-form text of unlimited length (e.g., detailed description of meteorological overview, etc)
- Links (e.g., to other databases/catalogues, external information such as reports, etc.)

A series of prompts (i) provide more information to assist with entering the required data. *Note, that this feature is only available in the Microsoft Word App, not in the SharePoint or Google Drive browser page*

IV. Notes

The warning value chain database will not 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 severe weather event. Basic data about each event are recorded in the 'Quick-look summary' table, links to other databases and catalogues (e.g., ECMWF severe event catalogue, EM-DAT, DesInventar, etc.) must be provided in *Annex 1*.

Quick-look summary

Editors (Name & Institute)	*Sara Harrison, Massey University/GNS*

HIGH IMPACT WEATHER EVENT		
Unique identifier i:		
Name of event	Canterbury Flooding	*Ref:*
When did it happen i? *Start? End? Duration?*	28 May 2021 - 1 June 2021 (rainfall event start and end dates, this doesn't include recovery)	*Ref:*
Where did it happen? *Main countries, states, counties, cities affected?*	Canterbury, New Zealand	*Ref:*
WHAT HAPPENED – WEATHER, HAZARDS, IMPACTS AND WARNINGS		
Weather event type/system that caused impacts i *Refer to Annex 2*	An atmospheric moisture anomaly (i.e., atmospheric river) produced heavy rainfall	*Ref:* *https://www.nzherald.co.nz/nz/weather-what-caused-the-canterbury-flood-three-questions-answered/BY2TK23FSO4LON5ZCMBJFSRKFQ/*
If possible, provide more detail about weather observations & forecasts (*link to page*)		
Hazards that caused the main impacts (if different from weather event) i *Refer to Annex 2*	Flooding King Tides Landslips	*Ref:* *https://www.nzherald.co.nz/nz/weather-canterbury-flooding-christchurch-roads-closed-high-tide-warnings/5SQRRXYMWF7B5UNDYBDHQGUXPI/*
If possible, provide more detail about hazard observations and forecasts (*link to page*)		
What were the main impacts i?	Over 300 homes evacuated Closures: highways, 75 schools and pre-schools, offices Damaged and collapsed bridges Boil water advisories in Ashburton, conserve water notice in Timaru Flooded farmland/farms Travel disruptions/flight cancellations	*Ref:* *https://www.rnz.co.nz/news/national/443699/live-canterbury-flooding-updates-bridges-collapse-hundreds-of-homes-evacuated?fbclid=IwAR205m43uIhjN5PTpD7WjuJydDrmOm1W*

Commented [2]: I anticipate this to contain all searchable data if possible. Adding a field with keywords could help too (I saw that somewhere but can't remember where)

Commented [3R2]: I agree. We might use tool tips in the word document and online version

Commented [4R2]: I added screen tips indicated with an i

Commented [5]: Irasema: Add multiple hazards if applicable

	Rescue missions from the NZ Army Agricultural impacts	*SAeTGvAqRgMeghyKKcPCCHXrNVs* *https://www.ashburtondc.govt.nz/news/notices-and-advisories/30-may-2021-weather-event-updates* *https://www.nzherald.co.nz/nz/weather-canterbury-rain-floods-rivers-rage-in-ashburton-and-waimakariri-residents-evacuated-from-homes/PMHPVVTUXZ3TUDNJCTVUCNDQXM/* *https://www.stuff.co.nz/national/weather-news/300320099/canterbury-floods-live-evacuations-amid-regional-emergency* *https://www.rnz.co.nz/news/national/443653/canterbury-flooding-thousands-in-ashburton-prepare-to-evacuate* *https://www.odt.co.nz/star-news/star-districts/heavy-rain-sets-canterbury-upper-south-island*
Total damage (insured + uninsured)	Ashburton Mayor Neil Brown is predicting the floodwater clean up cost could stretch into the tens of millions of dollars. It will be a while until insured/uninsured damages are available.	*Ref:* *https://www.rnz.co.nz/news/national/443699/live-canterbury-flooding-updates-bridges-collapse-hundreds-of-homes-evacuated?fbclid=IwAR205m43ulhjN5PTpD7WjuJydDrmOm1WSAeTGvAqRgMeghyKKcPCCHXrNVs*
People affected	Over 300 (no solid numbers available yet)	*Ref:*
Fatalities	N/A	*Ref:*
People injured	N/A	*Ref:*
If possible, provide more detail about hazard impacts (*link to page)*		
Main warnings/ watches/ advisories etc issued and by whom i:	**Meteorological warnings:** 26 May - MetService issued a "dynamic weather forecast" 27 May - MetService issued a Significant Rain Watch for Canterbury	*Ref: see social media screenshots* *MetService Facebook page* *https://www.facebook.com/Me*

Commented [6]: Adding some common metrics found in other databases that people are used to look for/filter

Commented [7]: Suggest adding another element or box to indicate when potential event was first detected in NWP, when decision to share/notify/discuss with primary partners occurred, and the timing of first broader social/public awareness (through social/traditional media).

Commented [8R7]: This could fit the box below about 'how successful were the forecast and warnings'. The communication bit ties in with How well warnings were communicated, maybe we need to specify this a bit more clearly in both cases.

Commented [9R7]: Added Brian's suggestion to detailed section

	28 May 11:23 - MetService issued: - RED Warning for Heavy Rain in Canterbury, south of Ashley - ORANGE Warning for Heavy Rain in Nelson, west of Motueka - Heavy Rain Watches for Bay of Plenty, Taranaki, the Richmond Range, Marlborough and Canterbury, north of Ashley - Strong wind watch for the South Island West Coast - Thunderstorm risk for north and west of the North Island and Nelson 29 May 10:47 - MetService issued: - RED Warning for Heavy Rain in Canterbury south of Amberley - ORANGE Warning for Heavy Rain for the rest of Canterbury and Marlborough - ORANGE Warning for Heavy Rain for Nelson, west of Motueka - ORANGE Warning for Strong Wind for Westland south of Hokitika and Fiordland **Flood warnings:** 30 May 5:08 - Environment Canterbury issued a Flood Advisory for Ashburton and Hinds Catchments 31 May 14:45 - Environment Canterbury issued a Flood Advisory update for Orari, Geraldine, Waihi	*tService* *Environment Canterbury Facebook page: https://www.facebook.com/EnvironmentCanterbury/* *https://www.ecan.govt.nz/get-involved/news-and-events/2021/flooding-updates-canterbury-region/*
Provide more detail about warnings (*link to page*)		
Responses and mitigating actions taken i:	Evacuations of people and animals from flood risk zones, sandbagging	*Ref: Media links above*
If possible, provide more detail about responses to advisories and warnings (*link to page*)		
HOW SUCCESSFUL WERE THE FORECASTS & WARNINGS		
How well was the weather forecast?	*Scale of 1 (poor) to 5 (excellent):*	*Ref:*
What aspects were poorly forecast?	*Make brief comments as appropriate.*	
How well were the hazards forecast?	*Scale of 1 (poor) to 5 (excellent):*	*Ref:*
What aspects were poorly forecast?	*Make brief comments as appropriate.*	
How well were the impacts forecast?	*Scale of 1 (poor) to 5 (excellent):*	*Ref:*
What aspects were poorly forecast?	*Make brief comments as appropriate.*	

Commented [10]: Important to distinguish exceptional/unique/additive responses from routine/expected/operational responses to event (here and/or in detailed account)

Commented [11R10]: I added this for the detailed part.

Commented [12R10]: Rather add responses in terms of 'evacuation/panic/business as usual'? Or add?

Commented [13]: For discussion!!!

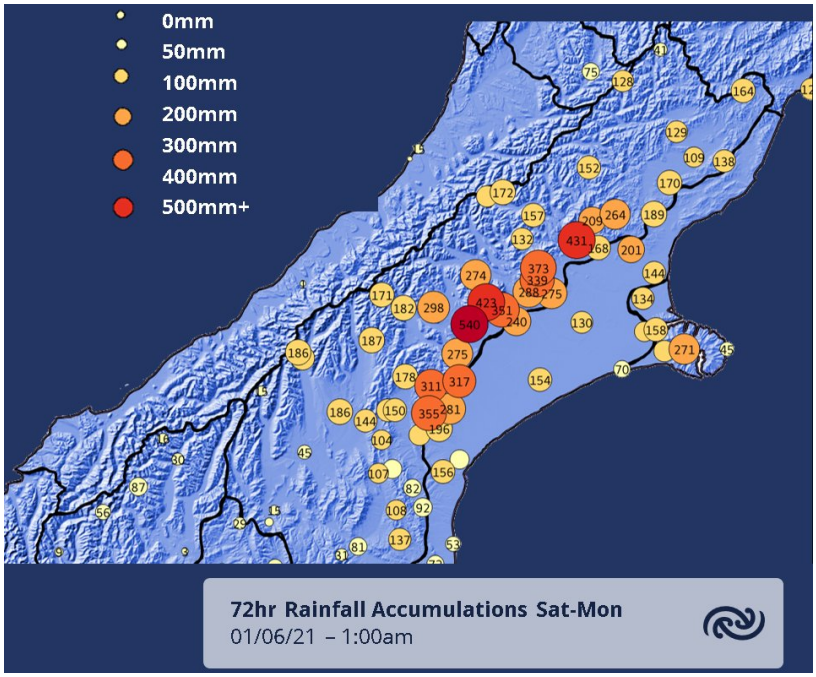
How well were warnings communicated?	*Scale of 1 (poor) to 5 (excellent):*	*Ref:*
What was poorly communicated?	*Make brief comments as appropriate.*	
How well were the warnings used?	*Scale of 1 (poor) to 5 (excellent):*	*Ref:*
Was action taken in response to the warnings?	*Key actions taken were sandbagging and evacuating people from flood risk zones.*	
Weak links in the warning chain? i	It is not clear if any flood warnings were issued, aside from flood advisories. This is an area that needs more clarity in NZ; each regional council operates differently in this aspect.	*Ref:*
If possible, provide more detail about the end-to-end warning chain, what worked well and what worked less well, and how this influenced the response actions (*link to page)*		

Additional information about weather

Editors (Name & Institute):
Meteorological overview (brief description of the weather event)

Observations

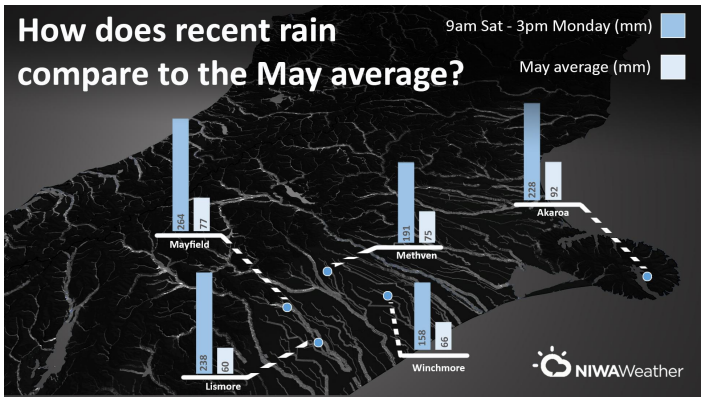
Weather observations and analyses (charts, time series, etc.) including data from unofficial sources where relevant



Mt Somers totaled 540mm - more than nearby Oamaru gets in a typical year, or even notoriously wet Milford Sound gets in an average winter month. Source: Twitter

https://watchers.news/2021/06/14/niwa-releases-figures-for-historical-one-in-200-year-flooding-in-canterbury-new-zealand/

How did the weather relate to climatology and/or previous extreme events? (how extreme, previous examples)



About 2 to 3 months worth of rain fell in only 2 to 3 days. For Canterbury, rainfall is 200-400% of what is normally received in May. Lismore, near Ashburton, received 238 mm in the last 2.2 days, the same amount it had received in the previous 187 days. Source: NIWA Twitter

Predictions

Weather models examined

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

Name	Version	Resolution	Ensemble size	Forecast length

Deterministic weather forecasts (charts, time series, etc.)

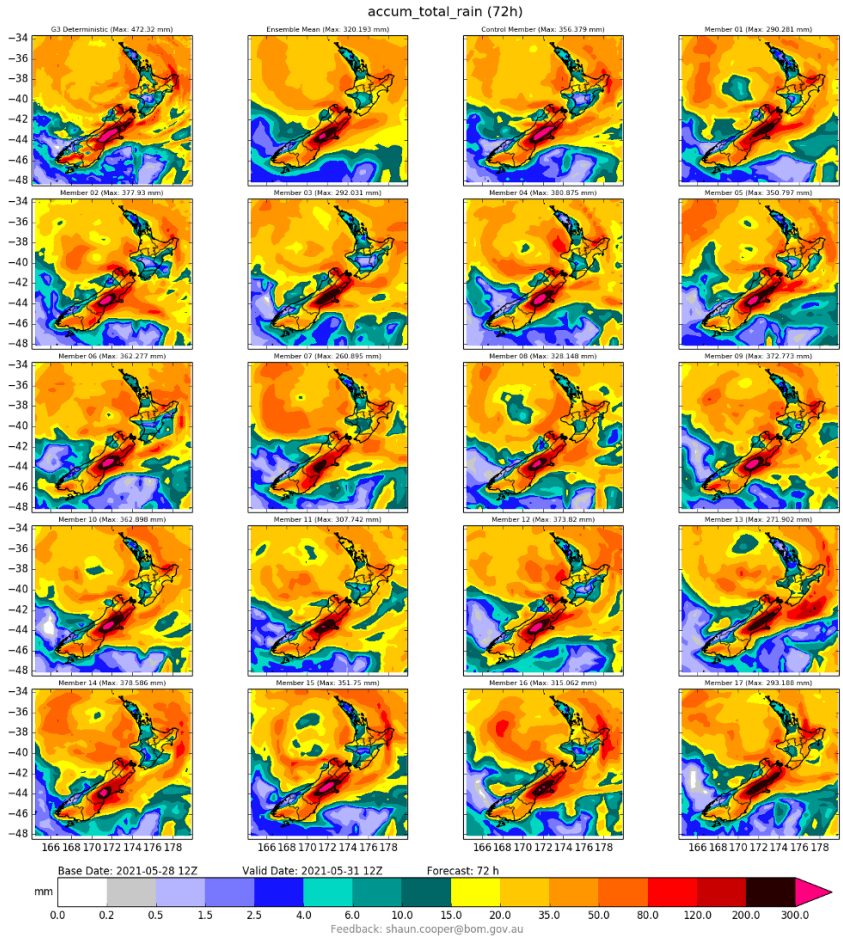
Ensemble/probabilistic weather forecasts (charts, time series, etc.)

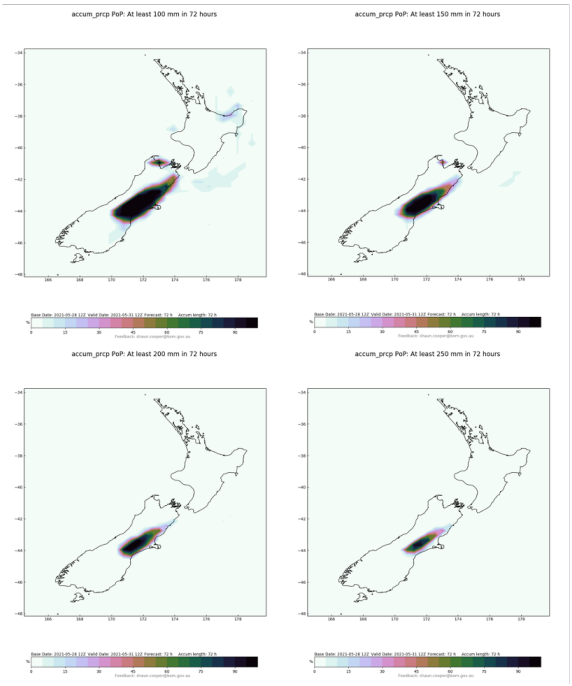
ACCESS G3 and GE3 Rainfall Forecast, 3-day forecast of total rainfall accumulation:
Valid Date: 2021-05-31 12Z, Base Date: 2021-05-28 12Z

Commented [14]: I think this is implied, but suggest explicitly using/adding a broader term to any use of 'forecast' such as "guidance" that forces inclusion of discussions, metnotes, audio/video/SM products, etc. to capture the interpretation of uncertainty, model trends, favoured model depictions, etc. that seem to influence downstream warning timing, info content.

Commented [15R14]: It is implied but maybe not explicitly enough. Particularly because we're not mentioning uncertainties but that might be routine for weather forecast maps, i.e. ensemble forecast below?

Commented [16]: Chiara: "how was the level of agreement between the different forecasts"


accum_total_rain (72h)
G3 Deterministic (Max: 472.32 mm)
Ensemble Mean (Max: 320.193 mm)
Control Member (Max: 356.379 mm)
Member 01 (Max: 290.281 mm)
Member 02 (Max: 377.93 mm)
Member 03 (Max: 292.031 mm)
Member 04 (Max: 380.875 mm)
Member 05 (Max: 350.797 mm)
Member 06 (Max: 362.277 mm)
Member 07 (Max: 260.895 mm)
Member 08 (Max: 328.148 mm)
Member 09 (Max: 372.773 mm)
Member 10 (Max: 362.898 mm)
Member 11 (Max: 307.742 mm)
Member 12 (Max: 373.82 mm)
Member 13 (Max: 271.902 mm)
Member 14 (Max: 378.586 mm)
Member 15 (Max: 351.75 mm)
Member 16 (Max: 315.062 mm)
Member 17 (Max: 293.188 mm)
−34 −36 −38 −40 −42 −44 −46 −48
166 168 170 172 174 176 178
Base Date: 2021-05-28 12Z
Valid Date: 2021-05-31 12Z
Forecast: 72 h
mm
0.0 0.2 0.5 1.5 2.5 4.0 6.0 10.0 15.0 20.0 35.0 50.0 80.0 120.0 200.0 300.0
Feedback: shaun.cooper@bom.gov.au



How reliable and accurate were forecasts at different lead times?

Commented [17]: Chiara: reliability at different spatial scales

When was the potential event first detected in NWP?

Available guidance (discussions of uncertainty and model trends, met notes, audio/video/SMS products, etc.)

Successes/issues/challenges experienced?

Additional information about hazards

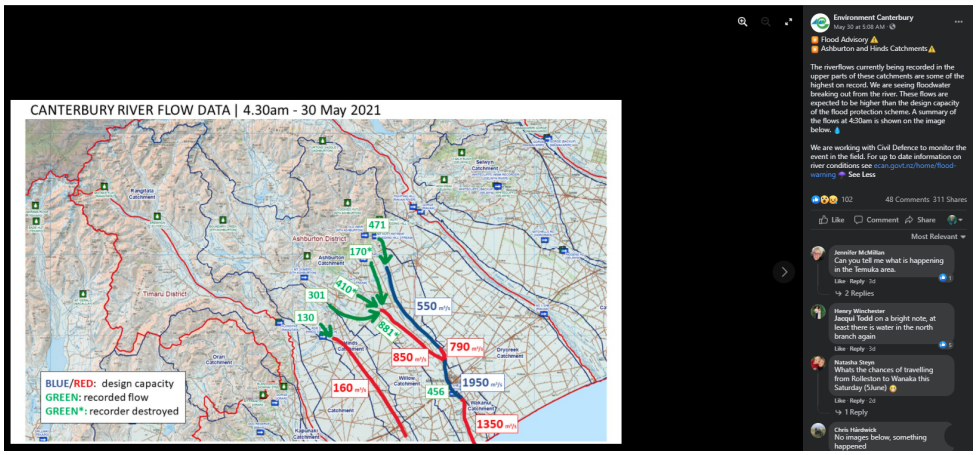
Commented [18]: Irasema: Accommodate whether the hazards occurred 'simultaneously', 'cascadingly' or 'cumulatively over time'

Editors (Name & Institute): Sara Harrison, Massey University/GNS Science

Brief overview of the hazard event(s) (if distinct from the weather event)

Observations

Hazard observations and analyses (charts, time series, etc.) including data from unofficial sources where relevant (e.g. flood levels/extent, wildfire spread, maximum wind gust speed, etc.)



How did the hazards relate to climatology? (how extreme, previous examples)

This event has been labeled a 1-in-100 year event (https://www.nzherald.co.nz/nz/weather-what-caused-the-canterbury-flood-three-questions-answered/BY2TK23FSO4LON5ZCMBJFSRKFQ/)

Were hazards made worse by pre-existing conditions?

Flooding was made worse by the pre-existing dry conditions, which meant heavy rain falling on cracked, dry soils, increasing the possibility of flood.

High/king tide also contributed to increased flooding in Christchurch (https://newsline.ccc.govt.nz/news/story/flooding-affecting-parts-of-christchurch-banks-peninsula).

Leaves blocking grates was also identified as a cause for flood in Christchurch (https://newsline.ccc.govt.nz/news/story/flooding-affecting-parts-of-christchurch-banks-peninsula).

Predictions

Hazard prediction models/tools examined

Name	Version	Resolution	Ensemble size	Forecast length

Deterministic hazard forecasts (charts, time series, etc.)

Ensemble/probabilistic hazard forecasts (charts, time series, etc.)

Informal rules/tools used to identify hazards (i.e. rules-of-thumb)

Additional analysis

Successes/issues/challenges experienced?

Commented [19]: It's important to find a place for informal or less formal tacit or experientially based knowledge about the 'expectation' of hazards (and impacts), i.e., rules-of-thumb (30mm in 6 hours = urban flood of area x-y-z), and discussions/interactions with partner agencies/practitioners/experts

Commented [20R19]: Adding 'Informal rules/tools used'?

Commented [21]: Would this replace the above?

Information flow in the value chain

Weather forecast inputs (repeat for each source)

What information was used?

- Meteorological information - rainfall forecasts and obs
- Hazard information - Flood models, river flow data

Who provided the information?

- Meteorological information - MetService (rainfall forecasts and obs), Canterbury Weather Updates (rainfall forecasts and obs), NIWA (rainfall forecasts and obs), Environment Canterbury (rainfall obs)
- Hazard information - NIWA (flood models), Environment Canterburyg (river flow data)

Nature of the information (machine-to-machine, briefings, online platforms, etc.)

- Social media posts

Other information inputs (if any)

What information was used?

Who provided the information?

Nature of the information (machine-to-machine, briefings, online platforms, etc.)

Additional information about impacts

Editors (Name & Institute): Sara Harrison, Massey University/GNS Science

Brief overview of the impact(s) (including any impact cascade)

>> additional aspects: (1) non-weather data (location and features of exposed people and assets, sources, validation), (2) ownership / responsibility / access regarding data and models in the chain up to impact projection, **(3)** ex-post comparisons of projected and occurred effects and impacts, (4) observed responses by affected agents (e.g. traffic counts, purchase behaviour via credit card records (total volume; categories), locational behaviour based on mobile phones), (5) behaviour in firms (e.g. pre-emptive closure), (6) pre-hazard physical resilience indicators (conditions of homes and infrastructure; infrastructure maintenance backlogs), (7) pre-hazard social resilience indicators (age structure, share of immobile people, share of inhabitants below poverty line, access to warning media, practical literacy)

Observations (including delayed impacts)

Health impacts (mortality, morbidity, injury, disease, physical and mental illness)

- Water contamination resulting in boil water advisories.
- As of 2 June 2021, no deaths or injuries were reported.

Critical infrastructure damage and service disruption (water supply, wastewater treatment, electricity, fuels, transportation, emergency response, health care, etc.)

- Water shortages leading to water conservation advisories.
- Wastewater overflows (https://newsline.ccc.govt.nz/news/story/flooding-affecting-parts-of-christchurch-banks-peninsula).
- Transportation: Road and highway closures, bridges damaged/closed, flight cancellations
- The NZ army was called in for rescue missions.
- State of emergency declared for the entire Canterbury Region

Other damage (destruction, repairable/replaceable, premature deterioration, social and business disruption, environmental damage, insured and uninsured losses, economic impact, etc.)

- 75 school and pre-school closures, office closures

Predictions

Impact prediction models/tools examined

Name	Version	Method	Forecast length

Impact forecasts: (charts, time series, probabilities etc.)

None - generic impact-oriented messaging was attached to the MetService warnings:

Informal rules/tools used to identify impacts (i.e. rules-of-thumb)

Who and what were exposed to the hazards, when, for how long and why?

Commented [22]: Delayed/lagged and cascading effects are important but so is the need to distinguish the impact or 'costs' of responses that may lead to some avoided losses, but also unintended secondary negative impacts that are not evenly distributed among populations, or across space/time (e.g., rolling electricity blackouts, facility/event closures, deferral of important medical treatments/medicines, upstream flooding to prevent downstream impacts, etc.)

Commented [23R22]: Separate section for delayed impacts that accommodates those secondary impacts? Is there a fixed timeframe as from when on an impact is delayed?

Commented [24]: See comment regarding informal rules/tools in hazard section

Commented [25R24]: Does it make sense to include it in the table or would those informal rules/tools only be applied outside the models?

Out of those exposed, who and what were vulnerable to the hazards and why? (pre-conditions, demographics, etc.)

Successes/issues/challenges experienced?

- People tampered with pumps leading to an increase in police presence to prevent further tampering.
- A flood gate was stuck open leading to the evacuation of residents in The Pines Beach, particularly around Dunns Ave.

Information flow in the value chain

Weather & Hazard information inputs (repeat for each source)

What information was used?

- Impact information - impact-oriented messaging

Who provided the information?

- Impact information - CDEM, Environment Canterbury, Canterbury Weather Updates

Nature of the information (machine-to-machine, briefings, online platforms, etc.)

- Social media posts (Facebook and Twitter)

Other information inputs (e.g. exposure and vulnerability)

What information was used?

Who provided the information?

Nature of the information (machine-to-machine, briefings, online platforms, etc.)

Commented [26]: I think it's really critical to connect exposure/vulnerability back to the communications where possible; in some/many? cases the disproportionate exp/vulnerability may also concentrate around the same situations/people who have difficulty receiving, understanding, and applying the forecast information we churn out—this area is one of the key research topics that HIWeather can begin informing through the value/warning chain work.

Commented [27R26]: Connected to 'Communication issues/challenges experienced' part in the Warning section? Asking if exposed/vulnerable population was properly addressed/reached and if, what their response was?

Additional information about warning communication

Editors (Name & Institute):

Brief overview of the communication "story" (ideally in chronological order, including media, official warnings, social media, etc)

MetService NZ National Forecast for Saturday 29th May 2021 led with information about the red severe warning for heavy rain near Canterbury, then most of the forecast focused on rainfall (https://www.youtube.com/watch?v=W71oIgyZLgg)

What were the main sources of information to emergency responders about the hazard & its impact? (formal and informal, including any warnings issued in the table below?)

What were the main sources of information to the public about the hazard & its impact? (formal and informal, include any warnings issued in table below)

When were decision made to share/notify/discuss with primary partners, and the timing of first broader social/public awareness? (through social/traditional media)

>>> it would be worthwhile to account for possible differentiation in the contents and way of presentation of information by available information channel, as well as possible differences in the access (free vs. charged, professional vs. laymen level, spatial and/or temporal differences in information release, etc.)

Warnings issued

Type of warnings examined

Name & Ref (e.g. "watch")	Lead time (before 1st impact)	Likelihood & severity (or risk level)	Who issued by	Who issued to	Channels used (e.g. TV, CAP)	Content & format	Reach

Warnings

Expand on the information provided in selected warnings, the way it was communicated, visualisation and how it addressed the needs of the recipient, with evidence where available.

Communication success/issues/challenges experienced (e.g, rumours, trust, risk perception, message receipt, beliefs, policies, practices, etc.)

Information flow in the value chain

Weather, Hazard & Impact information inputs used for warnings (repeat for each source)

What information was used?

Who provided the information?

Commented [28]: @Carla Mooney we need your help on this page!

Commented [29]: I think the details are noted below, but it will be important to convey the evolution of the warning and related messaging over the course of the event (and immediate post-event). Classic 'flip-flops' in forecasts but perhap`s more importantly the shifts that occur once a phenomenon/storm initiates after being predicted in model space for some time, again when conditions and eventually impacts begin being reported and affecting the region of interest.

Commented [30R29]: Part of the 'brief overview of the communication "story"' in the warning section? Do you mean a timeline of when watches change to actual warnings?

Commented [31]: I am a bit confused about this question.
Do we want to know who provided the information or how it was provided?

The source could be the Met Agency
Who provide formal warning products but also ad hoc (informal) briefings

Are we wanting to tease out if there are different services to emergency services and the public with these two questions?

Commented [32]: Is this covered in the communication story above?

Commented [33R32]: Partially yes but more detail on this can be provided here since the top asks for a brief overview only.

Commented [34]: This should be included below where one can expand on the warnings listed in the table. Will add this to the information bubble/guide

Commented [35]: List only different types and frequency of warnings instead of all warning issued

Deleted: W

Commented [36]: I think this is covered in the table.

Do we want to ask for a qualitative comment about the warnings instead?

Commented [37R36]: This part is particularly for warning graphics and such things that cannot be accommodated in the table above.

Nature of the information (machine-to-machine, briefings, online platforms, etc.)

<u>Other information inputs (e.g. exposure and vulnerability)</u>

What information was used?

Who provided the information?

Nature of the information (machine-to-machine, briefings, online platforms, etc.)

Additional information about responses

Editors (Name & Institute):

Brief overview of the response (e.g., organised evacuation, panic, business-as-usual, …)

What were the main responses to warnings?

Distinguish exceptional/unique/additive responses from routine/expected/operational responses to event

What are the sources of information on responses?

Commented [38]: From Brian M: distinguish exceptional/unique/additive responses from routine/expected/operational responses to event

Expands on the question in the quick-look table

Commented [39]: I am a bit unclear about this question. Are we asking where they got information or what information they have?

Responses

What responses were reported and how effective were they? Differentiate between routine and exceptional responses

Mitigating action	Taken by whom	When taken	On the basis of what information?	Benefit (if any)	Cost or impact of action

Commented [40]: How are response and mitigating action similar/different?

Commented [41]: See comments above regarding delayed impacts; Can be captured to some extent in this column. Also distinction between routine vs. exceptional responses demanding extra effort/resources (may be important for attribution of impact/cost/benefits)

Commented [42R41]: Might be worth adding an additional column for delayed impacts but doesn't that fit better in the 'impact section'?

Analysis of responses

Expand on the information provided on selected responses, including those that were of no value and the reasons for success (or failure).

Analysis of the end-to-end warning chain

Editors (Name & Institute):

Were forecasts and warnings timely enough for decision making?

Were forecasts and warnings relevant and fit-for purpose?

Were protective mitigating actions taken?

What aspects of the warning chain contributed to more appropriate warning responses?

What aspects of the warning chain contributed to less appropriate warning responses?

Did any part of the warning chain fail to operate altogether? If so, how was this dealt with?

Is there evidence that fatalities, injuries, damage, and disruption were prevented? If so, is it possible to identify which aspects of the warnings or other communications were most effective in achieving this?

What procedures have been used to identify and implement lessons learned from the event (e.g. inquiries, post-event reviews, etc.)**?**

Were lessons learnt from previous events implemented?

Commented [43]: I think we need to be careful in suggesting what is 'appropriate' especially in terms of response being mindful of non-weather factors (resource levels, socio-cultural, etc.) that overwhelmingly dictate who/what/when is vulnerable and impacts, and what can be done during an event. We at least need to acknowledge and condition our definition/interpretation of 'appropriate' alternatives or sequences of responses.

Commented [44R43]: Indeed, get back to Brian G to clarify that? He came up with those questions. Carla, do you have an idea what could be 'appropriate'?

Commented [45]: Appropriate meaning the community benefitted from those actions?

Commented [46R45]: Carla suggested 'protective' instead of 'appropriate' which I like

Acknowledgements (e.g., information providers)

- Shaun Cooper (BOM) for providing ACCESS G3 and GE3 Rainfall Forecast, and information on rainfall observations

Annex 1: Useful links *(ECMWF catalogue of severe events, WMO CHE, DesInventar, EM-DAT, GLIDE, etc.)*

ECMWF catalogue of severe events entry: https://confluence.ecmwf.int/display/FCST/202105+-+Rainfall+-+New+Zeeland

Annex 2: Hazard types – *Pre-defined hazards in the Sendai Framework Monitor*

Blizzard	Extra-tropical storm	Lightning
Coastal erosion	Extreme temperature	Ponding flood
Coastal flood	Fire	Rain
Cold wave	Flash flood	Riverine flood
Convective storm	Flood	Snow
Cyclone surge	Fog	Tornado
Cyclonic rain	Freeze	Tropical cyclone
Cyclonic wind	Frost	Urban flood
Derecho	Hail	Wave action
Drought	Heat wave	Wildfire
Dust	Ice	Wind