



IMPACT-BASED FORECASTING FOR THE COASTAL ZONE – EAST COAST LOWS

Annual report 2019-2020

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Australian Government
Geoscience Australia



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Bureau of Meteorology



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Cover: Wind and rain hazards. Source: Harald Richter.



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ACKNOWLEDGMENTS

The project is grateful to Anthony Day and Simon Gethin from the NSW SES for the provision of the BEACON damage assessment data for the 20-22 April 2015 East Coast Low event, and to John Moore from FRNSW for the provision of the EICU dataset for the same event.



EXECUTIVE SUMMARY

The bushfire and Natural Hazards CRC project Impact-based forecasting for the coastal zone: East-Coast Lows demonstrates a pilot capability to deliver quantitative impact forecasts for residential housing from the Bureau's high resolution weather prediction models (or high resolution reanalysis for hindcasts). The project is a collaborative effort between the Australian Bureau of Meteorology and Geoscience Australia.

The project goals include¹:

- Determination of the type of impact information based on the wind hazard that would be most valuable to end users
- Development and testing of an approach to integrate numerical weather (wind) forecasts, vulnerability relationships and exposure data at the community level
- Development of spatially and temporally varying and meaningful impact information
- Testing of the project approach for a small number of previous events
- Development of a pilot quantitative wind impact-based forecasting system.

The project focuses on the wind impact on residential buildings from the 20-22 April 2015 east coast low event in New South Wales (a.k.a. the "Dungog case study"; Wehner and Maqsood 2015). The wind hazard data is provided by the high resolution version of the Australian Community Climate Earth System Simulator (ACCESS; Bureau of Meteorology 2018) model, or the equivalent high resolution reanalysis (BARRA-SY). The two damage data sets have been provided by NSW State Emergency Services (SES) and the Emergency Information Coordination Unit (EICU). Exposure and vulnerability information has been sourced from Geoscience Australia. Exposure data are sourced from the National Exposure Information System (NEXIS; Nadimpalli et al. 2007; Power et al. 2017), and heuristically derived vulnerability functions have been compiled as part of a previous project.

The multi-hazard nature of the east coast low event, the relatively low wind speeds and the limited available information in the damage assessment data makes attributing the observed building damage to the specific wind hazard very difficult. To evaluate the performance of the quantitative wind impact forecast that we have produced, very careful and detailed processing of the available damage data is needed to remove damage reports due to tree fall, as opposed to structural failure, rain ingress, and flood inundation.

Despite the challenges above, we have now shown that the inclusion of exposure and vulnerability information can outperform a wind impact forecast that only uses a plain wind hazard prediction. In other words, the Dungog case study suggests that the extra effort needed for the quantitative inclusion of

¹ For more background information on the project background see previous year's report: [2017-18 Annual Report](#)



exposure and vulnerability information is a promising approach in the pursuit of future quantitative impact forecasts in Australia.

We applied our impact forecast methodology to a second extreme weather case during May 2020 in Perth. An extra-tropical cyclone produced widespread wind damage with wind gusts in excess of 100 km/h recorded over many hours. In this case we found that wind impact forecasts are sensitive to the fluctuations in wind gust forecasts produced by the Bureau's high-resolution real-time weather prediction models. Alongside the multi-hazard nature of damage to residential buildings, this impact sensitivity to the hazard constitutes a second complication for the quantitative prediction of wind impacts.

To increase the utility of the damage assessment data we continue to recommend that the SES/EICU damage survey templates record multiple damage states and linkages between damage and the associated hazard(s). Such expanded recording practices would lead to improvements in the development of the hazard-damage relationships. Additional uncertainty arises through the NEXIS exposure data which are statistically inferred at the Dungog township and are therefore merely indicative of the actual building attributes.



END-USER PROJECT IMPACT STATEMENT

Simon Louis, *TAS Regional Office, Bureau of Meteorology*

A core pillar of the mission of the Bureau of Meteorology and our partners in emergency services is to reduce the loss of life and damage to property in extreme weather events. Critical to this mission is the ability to provide forecasts and warnings of weather conditions in a way that facilitates effective decision making by officials and members of the public. These decisions can range from the type of language used in public messaging, to pre-positioning of emergency response teams, to tactical decisions made by on-the-ground responders. Fundamental to this decision-making process is the ability to match up intelligence about likely weather conditions with knowledge about risks and vulnerabilities in the community.

The work of the Impact Based Forecasting BNHCRC project team is a critical first step in bridging this gap between hazards associated with weather conditions and the vulnerability of the community to the hazards. By establishing a proof of concept approach to combining these two pieces of the puzzle to produce explicit forecasts of impacts from extreme weather events, this work will lay the ground work for potential future operational impact based forecasting systems. A key challenge in designing a system of this type lies in gathering disparate sources of data and making sure that existing procedures for collecting impact data are fit for purpose. An important output from the project may include recommendations on how impact data are collected in future.

It is likely that explicit impact forecasting systems will become a key part of the tool kit for operational meteorologists and emergency services in the future. I look forward to the continued work of the BNHCRC team exploring the possibilities in this area.



PRODUCT USER TESTIMONIALS

Roger Mentha, *Fire and Rescue NSW*

The project has brought significant research to end users at both the AFAC conference in Melbourne and the Research Advisory Forum in Perth. These two engagements provided opportunity for direct feedback from end users and the opportunity to bring the scientific experts and emergency service end users together. Presentation of options for utilisations and feedback from end users on applying the research to protecting critical infrastructure was beneficial and will assist year 3 outcomes.



DATA & METHODS

See previous/initial Annual Reports [2017-18 Report] for a detailed summary of terminology and approaches used in the project. Below, only the essential steps and differences to previous reports are highlighted.

HAZARD DATA

The project is focusing on wind hazard data only. Previous attempts to also include rain hazard predictions to investigate impacts due to rain ingress proved not fruitful as no meaningful quantitative rain vulnerability functions exist. Attempts to derive these from the Dungog damage data failed, with the results showing extreme sensitivity to minor changes in the damage data points used. The wind hazard information was either derived from BARRY-SY, the Bureau's high resolution reanalysis for the Sydney region (Dungog event), or from ACCESS-City Perth, the Bureau's high resolution model for the Perth region (for the Perth event).

VULNERABILITY DATA

Given 2015 Dungog case did not provide sufficient damage assessment data to derive adequate vulnerability relations, the project continues to use existing heuristic wind vulnerability functions based on tropical and extra-tropical cyclone events. These functions were developed using a hazard estimator (wind speed) based on a 0.2 second duration gust, which can readily be related to the 3-second duration gust diagnosed in ACCESS-C and BARRA-SY (e.g., Holmes and Ginger, 2012).

EXPOSURE DATA

No changes or highlights to report relating to the National Exposure Information System (NEXIS) exposure data used in the project.

THE WORKFLOW

The workflow for the project has not changed since we issued our previous annual report. In short, wind gust forecasts from the Bureau's high resolution models (for forecasts) or reanalyses (for hindcasts) are integrated with NEXIS exposure information and heuristically derived wind vulnerability information (for residential buildings only). A quantitative spatial wind impact forecast is produced, and can then be displayed through a variety of visualization systems, including the Bureau's operational Visual Weather software.

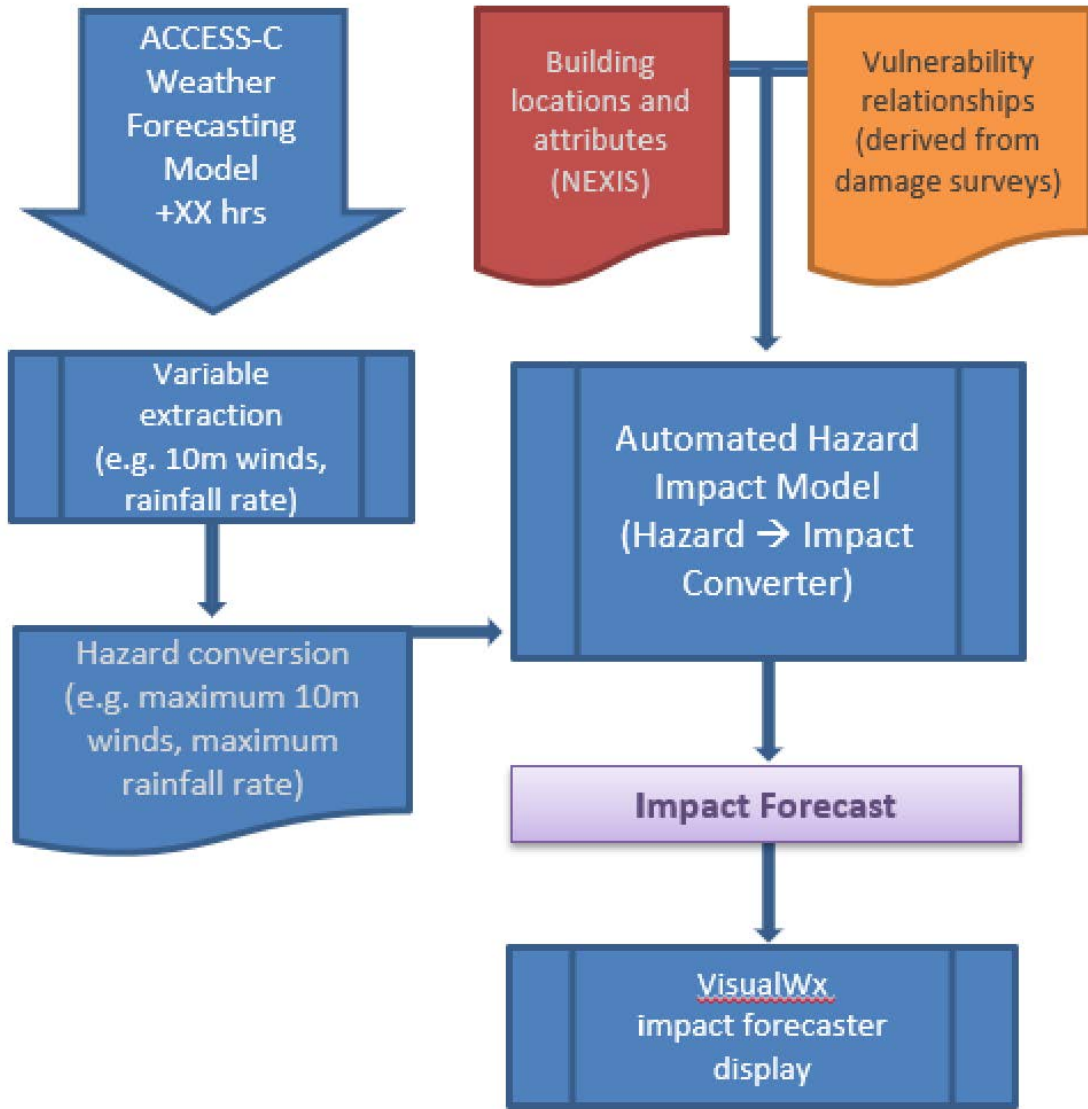


FIGURE 1. IDEALISED PROJECT WORKFLOW FROM HIGH RESOLUTION MODEL OR HIGH RESOLUTION REANALYSIS OUTPUT TO A SPATIAL DISPLAY OF IMPACTS IN THE BUREAU OF METEOROLOGY'S OPERATIONAL DATA DISPLAY SYSTEM (VISUAL WEATHER).



KEY MILESTONES

This report covers most of the third year of this three-year project. Below, only the major milestones delivered by the project during its third year are listed.

REFINED VALIDATION METHODOLOGY DEVELOPED AND INDICATIVE RESULTS GENERATED FOR THE WIND IMPACT MODEL

Despite the shortcomings of the currently available damage assessment data for the purposes of quantitative wind impact modelling for residential buildings, the project found a somewhat labour-intensive but viable approach to evaluate how our quantitative impact forecast for the 20-22 April 2015 East Coast Low event verifies against a hazard-only impact forecast.

The absence of information in the damage data that relates the recorded damage consistently and reliably to the underlying hazard that caused it has partially been offset through a sophisticated data filtering approach applied to the Emergency Coordination Information Unit (EICU) data. Damage records were assessed individually, so that any entries stating water levels, flooding, tree damage (and any other damage drivers that are not wind) could be removed. The BARRA-SY reanalysis rainfall was used to further remove all those damage entries where the reanalysed rainfall exceeded certain thresholds that are commonly relatable to overland flooding. We decided not to explicitly retain all those observed damage records where the reanalysis showed surface wind gusts in excess of damaging thresholds as such a filtering method would bias the retained damage assessment records in favour of the reanalysis-based impact forecast results themselves.

Damage observations and forecasts were divided into three categories each (minor, moderate, major; Table 1). The filtered damage assessment data were finally aggregated to SA-1 areas so they became comparable to the SA-1 aggregated impact forecasts from our impact model.

Observations			Forecast		
EICU damage state	Integer		SA1 mean structural loss ratio	Integer	
	5 Cat	3 Cat		5 Cat	3 Cat
No Damage – 0%	1	1	[0.00,0.02)	1	1
Minor Impact – 1-25%	2	2	[0.02,0.10)	2	2
Major Impact – 26-50%	3		[0.10,0.20)	3	
Severe Impact – 51-75%	4	3	[0.20,0.50)	4	3
Destroyed – 76-100%	5		[0.50,1.00]	5	

TABLE 1. THRESHOLDS CHOSEN TO CATEGORISE THE EMERGENCY INFORMATION COORDINATION UNIT (EICU) AND THE MODEL-PRODUCED SA1 MEAN STRUCTUREAL LOSS RATIO INTO 3 (5) DAMAGE CATEGORIES SUITABLE FOR THE MULTI-CATEGORY FORECAST TO FOLLOW.

A variety of verification scores were computed. The Gerrity Score (Jolliffe and Stephenson 2003, Gerrity 1992) was chosen as the primary assessment metric as it has a refined ability to penalize the degree of category mismatch between model and observations for a multi-category forecast. The skill of the quantitative impact forecast needs to be seen in comparison to the much easier straight wind forecast as a reference approach (Fig. 2).

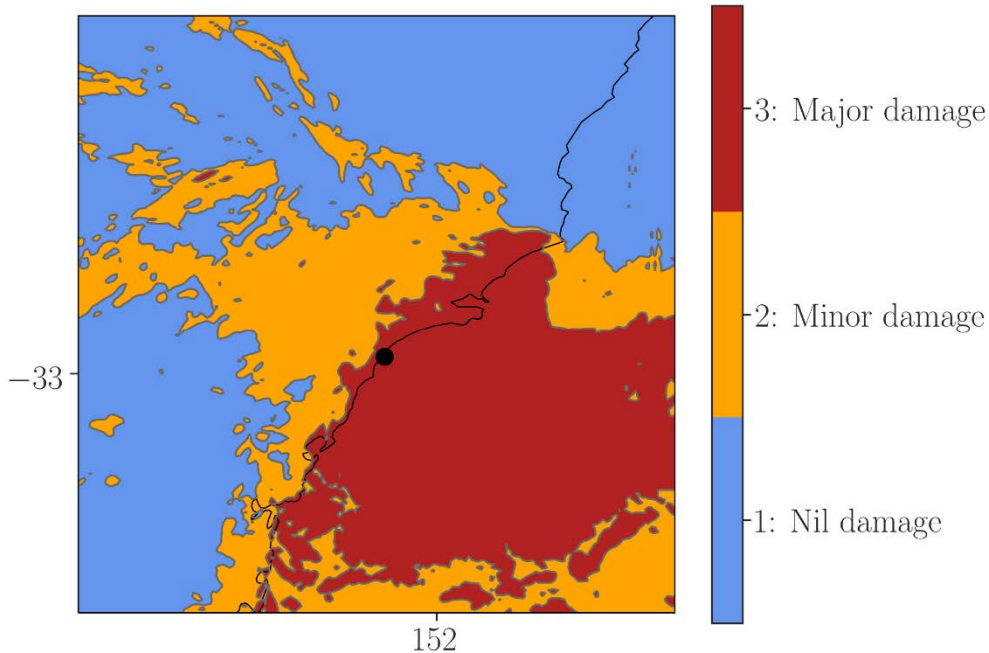


FIGURE 2. SIMPLE REFERENCE "IMPACT" FORECAST BASED SOLELY ON THE 20-22 APRIL 2015 DUNGOG EVENT MAXIMUM 10-M WIND GUSTS FROM THE BARRA-SY HIGH RESOLUTION REANALYSIS. THE WIND DAMAGE CATEGORIES ARE A SIMPLE MAPPING FROM THE MAXIMUM GUST SPEEDS: NIL (< 25 M S⁻¹), MINOR (25-34 M S⁻¹), MAJOR (> 34 M S⁻¹).

This comparison which utilizes the filtered EICU damage data reveals a clear skill increase due to the inclusion of exposure and vulnerability information, i.e. the skill gain due to enhancing a hazard forecast to an impact forecast. In particular a calibrated version of the full impact forecast (where the SA1 mean structural loss ratio boundaries between the three categories were set to deliver optimal skill) produced much better skill scores compared to the simple impact forecast. Our results for the 20-22 April 2015 Dungog case revealed that the impact forecasts substantially outperformed the plain re-mapped wind hazard forecast in Fig. 2 when assessed using the EICU damage data processed as described above. Therefore this project has demonstrated that the substantial effort required to pursue quantitative wind impact forecasts can lead to additional value compared to hazard-based wind damage estimates.

DRAFT FOR PEER-REVIEWED JOURNAL ARTICLE

The project has produced a full-sized review paper on published systems that aim to produce impact-flavored hydrometeorological forecasts. In this review we make an attempt to present a hierarchy that allows us to line up the various systems from 'almost pure hazard' all the way across to fully quantitative hazard impact models.

Most 'impact' forecasts that we surveyed only take modest steps beyond the forecast of the pure hazard. These steps may entail the provision of additional information such as the population size affected by a hazard. Such information



can be seen as a crude proxy for specific types of impacts, and its provision requires little extra effort beyond the hazard forecast itself. Models that use such stand-alone pieces of exposure or vulnerability proxies are also referred to as layered models, where the end user is left with the task to integrate the separate layers of information to estimate the final impact. An example of a layered impact model is the Convective Outlook product from one of the national weather forecast centres operated by the National Oceanic and Atmospheric Administration in the U.S., the Storm Prediction Center. Fig. 3 shows an example how the simple addition of potentially affected population numbers is used as a first step towards gauging the impact of a hazard-driven polygon outlining likely areas for severe convective storms.

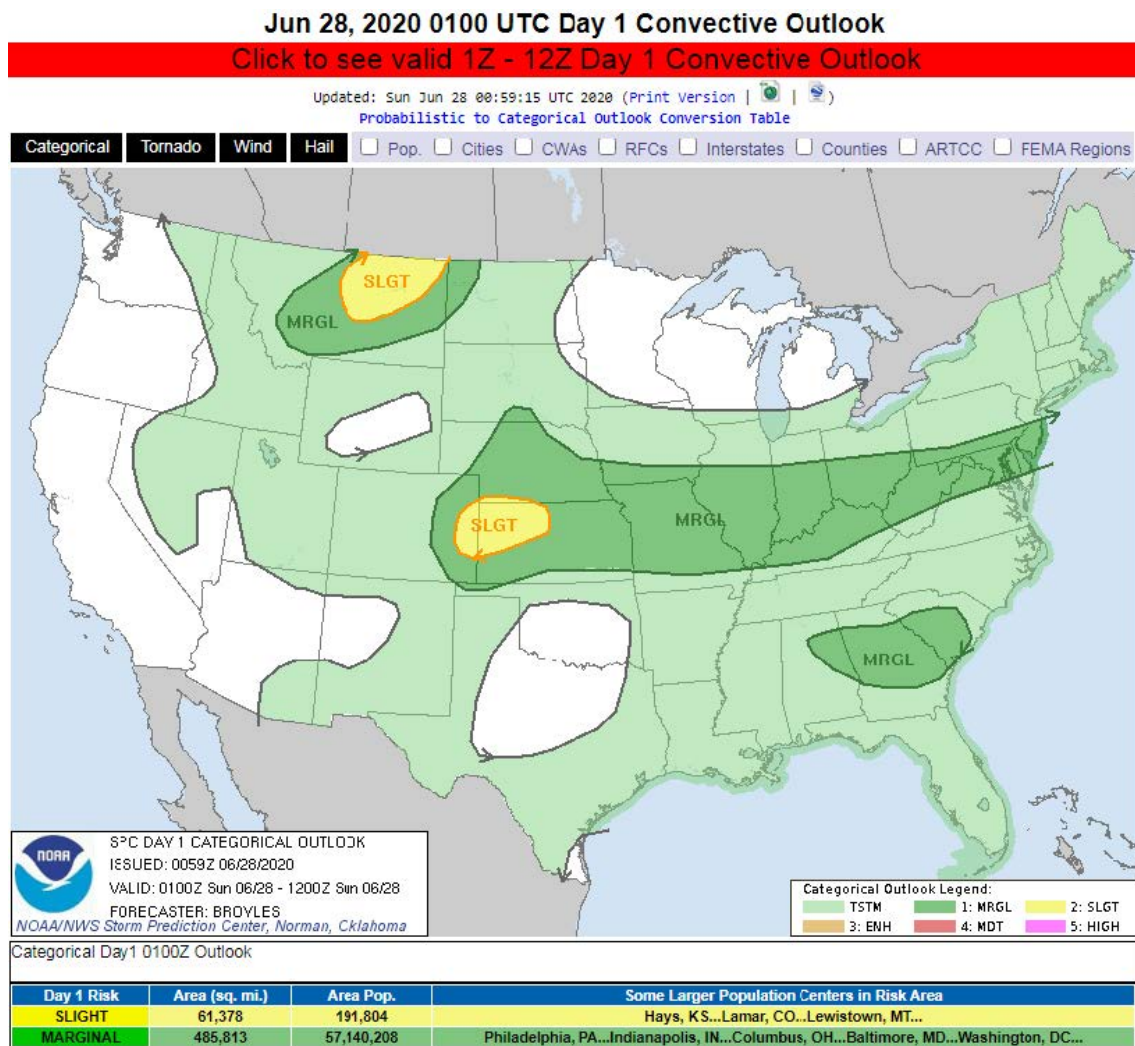


FIGURE 3. THE 'DAY 1' CONVECTIVE OUTLOOK PRODUCT FROM THE STORM PREDICTION CENTER IN THE UNITED STATES. THE CATEGORICAL AREAS MARKED 'SLIGHT' AND 'MARGINAL' ARE AREAS AT ENHANCED RISK OF BEING IMPACTED BY CONVECTIVELY GENERATED HAZARDS SUCH AS STRONG WINDS, LARGE HAIL OR TORNADOES. NOTE THE AREA SIZE AND POPULATION NUMBERS POTENTIALLY AFFECTED BY THESE AREAS OF ENHANCED RISK

A second approach to a simple impact estimate is to put hazard forecasts in their climatological context. Often physical impacts are not so much controlled by the absolute magnitude of a hazard, than they are by how 'unusual' the occurrence of a certain hazard magnitude is at a given geographic location.

At the impact end of the hazard-impact spectrum are the quantitative hazard impact models. Examples of these are the Vehicle Overtaking Model (VOT; Hemingway and Gunnavan 2018; Hemingway et al. 2014) and the Surface Water



Flooding Model (SWF; Aldridge et al. 2016; Hemingway and Gunawan 2018), both developed at the UK Met Office in conjunction with their partners. These models quantify connections between predicted spatial wind speeds and the likelihood of trucks overturning (for VOT), or predicted precipitation and the likelihood of overland flooding (for SWF). Such models are difficult to build due to the requirement to quantify a range of processes that aggregate to form the final impact. They also require extensive datasets to quantify exposure of assets to the hazard, and to quantify the vulnerability of those assets to the hazard.

In this context, our project is firmly positioned near the 'difficult' end of impact forecasting as it also attempts to quantify the role of hazard, exposure and vulnerability.

EXTENT WIND IMPACT FORECAST PILOT TO ALLOW MULTIPLE FORECAST LEAD TIMES

A strong extratropical cyclone that affected southwest Western Australia on 24 May 2020 was selected to test the influence of wind gust strength variations in successive model runs on the wind impact output.

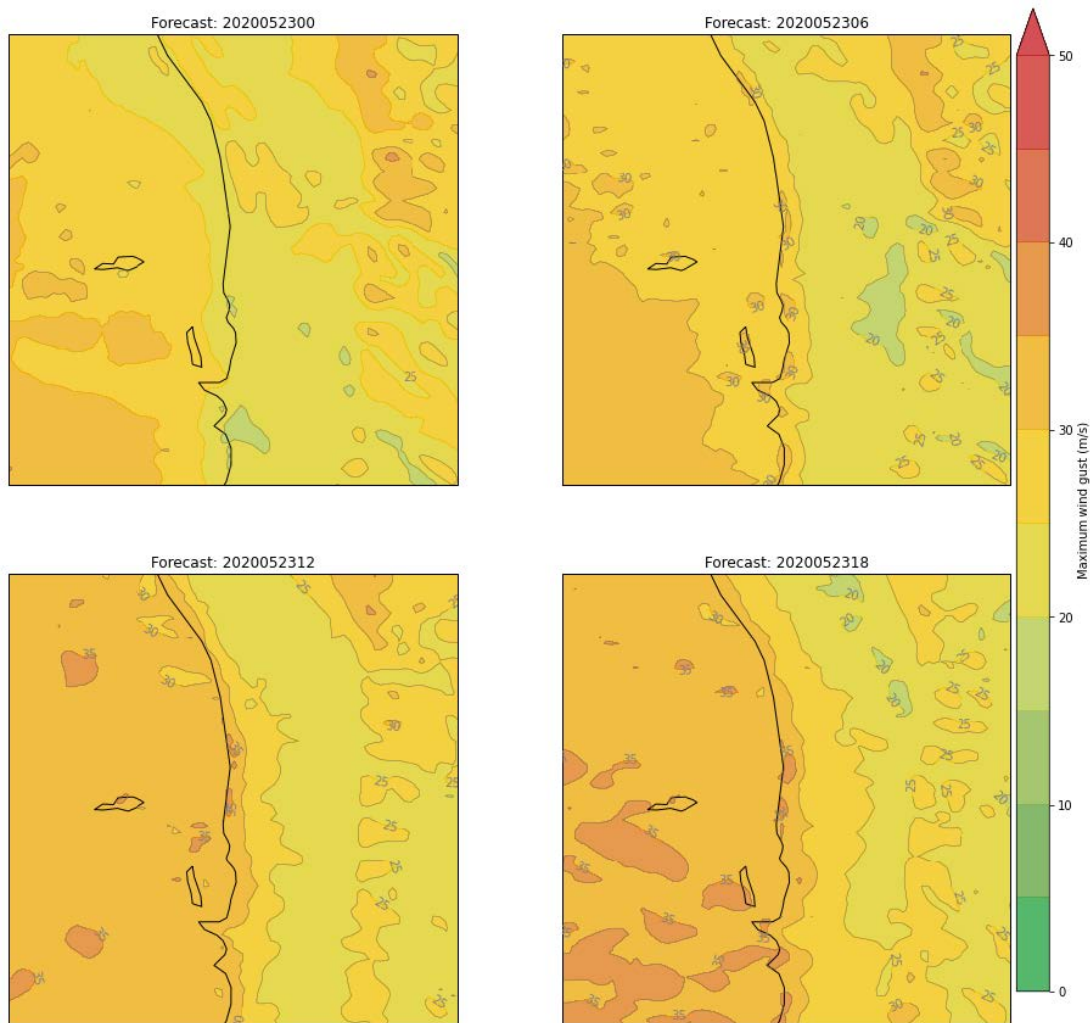


FIGURE 4. MAXIMUM 3-SECOND 10-M WIND GUST FORECASTS VALID AT 2100 UTC 23 MAY 2020 FOR FOUR ACCESS-PH SIMULATIONS INITIALIZED AT 0000 UTC 23 MAY 2020 (TOP LEFT), 0600 UTC 23 MAY 2020 (TOP RIGHT), 1200 UTC 23 MAY 2020 (BOTTOM LEFT) AND 1800 UTC 23 MAY 2020 (BOTTOM RIGHT). IN THIS CASE, THE HIGHEST WIND SPEEDS ARE FORECAST TO AFFECT THE GREATER PERTH METRO AREA IN THE FORECAST WITH THE SHORTEST LEAD TIME (3 HOURS), COINCIDING WITH THE APPROACH OF THE MAIN STORM. MAXIMUM MODEL WIND GUSTS AT 2100 UTC ARE IN EXCESS OF 35 M S^{-1} (126 KM HR^{-1}).



Four successive ACCESS-City model forecasts were used to produce wind fields in the Greater Perth Region valid at the same time (2100 UTC on 23 May 2020; Fig. 4). The large and intense extratropical cyclone was producing measured wind gusts in excess of 110 km hr⁻¹ around Perth, making it suitable for a wind impact assessment. The main result of this assessment is that the wind hazard prediction changes between a 21-hr forecast and a 3-hr forecast can translate to quantitative impact changes from negligible to moderate (Fig. 5). This sensitivity needs to be explored further in future studies and constitutes a second significant constraint on the potential usefulness of quantitative wind impact forecasts (in addition to the shortfalls of currently collected damage data for the derivation of vulnerability functions and verification of impact forecasts).

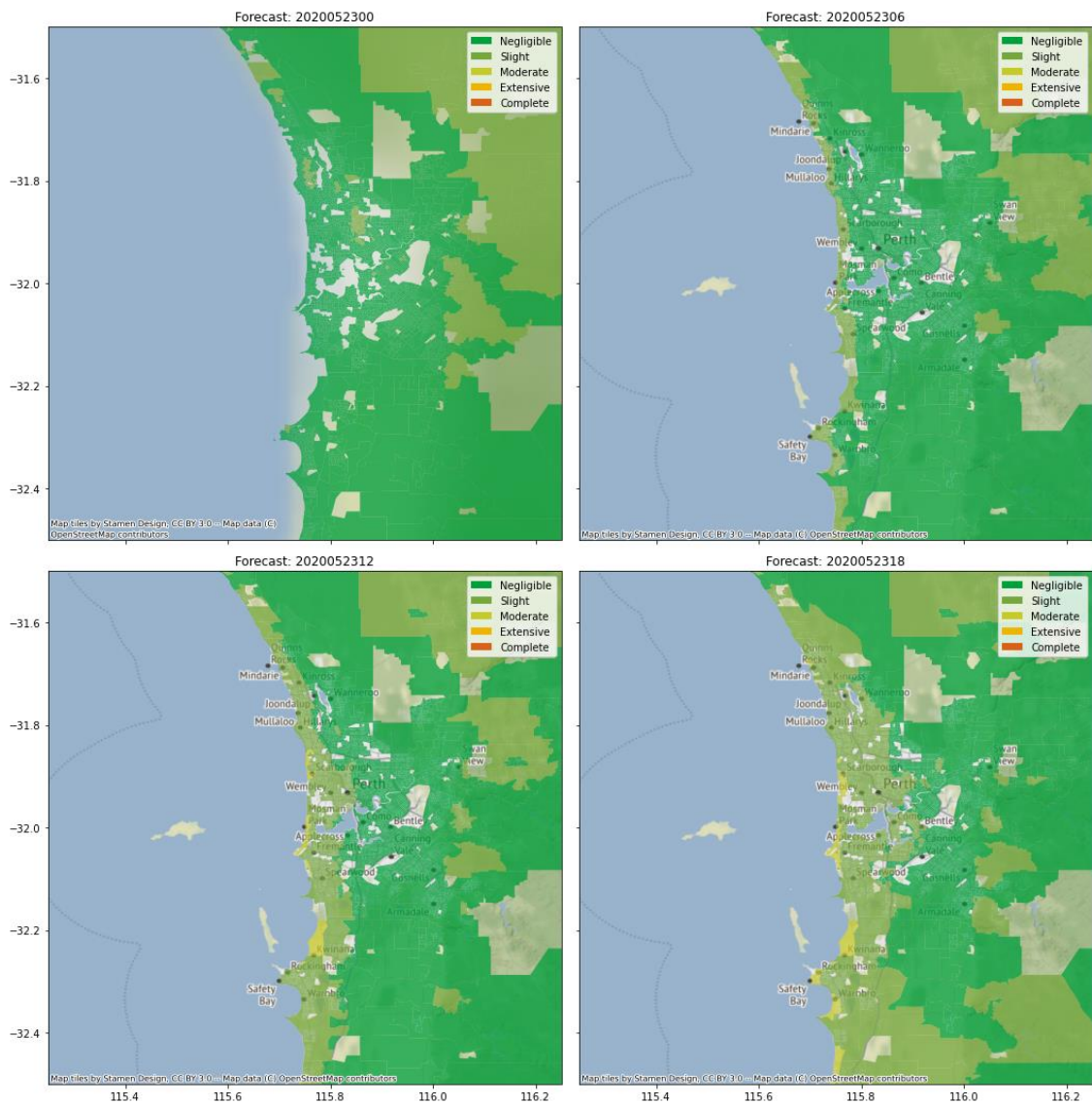


FIGURE 5. FORECAST MEAN DAMAGE STATE FOR SA1 GEOGRAPHIC AREAS AT 2100 UTC 23 MAY 2020 BASED ON THE FOUR SUCCESSIVE ACCESS-CITY MODEL INITIALIZATION TIMES LISTED WITH FIG. 4.

SOME INTERNATIONAL PERSPECTIVES ON IMPACT FORECASTING

A poster presentation was delivered by Harald to the European Conference on Severe Storms (ECSS) community of hazard prediction for a 2016 South Australian case using a more modern approach to interrogating output from high-resolution



convection-permitting models such as the underlying model used to specify the wind hazard for the Dungog case. This 'storm attribute' approach is still relatively new in European countries and therefore attracted some interest.

A key conversation with Elizabeth Webster from the South African Weather Service (SAWS) indicated that 'impact forecasts' at SAWS are not objectively derived model-based damage estimates, for example, but are hazard forecasts translated into qualitative and selected impacts by emergency managers on the ground. This approach means that emergency managers make the choices on which impacts deserve to be communicated, and which ones are left out.

At the UK Met Office a conversation with Joanne Robbins, head of the Weather Impacts Team, revealed that impact forecasting at the UKMO is also hampered by access problems to the required data, similar, or perhaps even more restrictive, to our own experience in Australia. The prime data access mechanism for Joanne's team is through the Natural Hazards Partnership, an association of government agencies, universities and other institutions.

Joanne also pointed out that impacts have multiple levels which can be seen as parts of the value chain. Physical impacts, such as blown-over trucks as predicted by the VOT above, create additional impacts further down the value chain: costs to businesses, travel time increases etc. The Bureau's intention to impact-based forecasting, for example, therefore faces the additional task of needing to specify how many, and which, layers of impact are within scope of its future service.

Finally, the UKMO launched one concerted effort to quantify wind impacts about 6 years ago, but the work did not result in useable outcomes at the time. It puts into perspective that the goals of this project are regarded as difficult, even at the most advanced impact forecasting organizations such as the UKMO.

SUMMARY

This project has delivered a pilot capability that demonstrates that a cross-agency collaboration can produce spatial quantitative wind impact forecasts. We have also shown that impact forecasts, when verified against the existing damage assessment data, can outperform hazard-only forecasts, traditionally issued by the Bureau of Meteorology. The available damage assessment data, however, remain only partially suited to furthering future advances for quantitative hazard impact forecasts. As stated multiple times before, the reported damage requires to be linked to the hazard or hazard combination that caused it, and it needs to be rated in some categorical fashion that allows the appraisal of how severe the damage has been.

National hydrometeorological centres around the globe have stated that impact (rather than hazard) forecasts are a major new strategic direction, so that our prototype study is well placed to meet an emerging vast need for ways to transition from hazard to impact forecasts. We have shown that it can be done across more than one federal agency, that it can verify better than a hazard-only forecasts, and what changes to damage data collection is required to enable us to advance quantitative impact forecasting to the next level.



NEXT STEPS

The project will move towards its closure over the next 3 months, finishing by 30 September 2020. A functioning quantitative wind impact prediction system that adds vulnerability and exposure information to an NWP-based hazard-only forecast now exists, as a deliverable produced across two federal agencies. We have shown, albeit with a range of significant caveats, that moving from hazard to impact prediction holds promise when verified against the damage data available today.

A second and final end user workshop will gather end user feedback on this development, and gauge how the existing prototype system can be improved further, and better meet operational needs of agencies such as the emergency managements agencies around Australia, and the Bureau of Meteorology that, in a major announcement on strategic direction, is committed to move from hazard to impact forecasts.



PUBLICATIONS LIST

NEW YEAR 3 PUBLICATIONS ONLY

PEER-REVIEWED JOURNAL ARTICLES

Schroeter, S., H. Richter, C. Arthur, D. Wilke, M. Dunford, B. Ebert, and M. Wehner: Forecasting the Impacts of Severe Weather. (In preparation for re-submission to the Journal of Southern Hemisphere Earth Systems Science)

Harald Richter, Craig Arthur, Serena Schroeter, Martin Wehner, Jane Sexton, Beth Ebert, Mark Dunford, Jeff Kepert, Shoni Maguire, Russel Hay, Mark Edwards: Impact Based Forecasting for the Coastal Zone. AFAC 2019, Extended Abstract.

INTERNATIONAL CONFERENCES

Harald Richter and Dean Sgarbossa: USE OF CONVECTION-ALLOWING MODEL ENSEMBLES IN FORECASTING SEVERE CONVECTIVE HAZARDS IN AUSTRALIA. European Conference on Severe Storms 2019, Krakow, Poland.

BNHCRC EXTERNAL REPORTS

None.

AUSTRALIAN METEOROLOGICAL AND OCEANOGRAPHIC SOCIETY (AMOS) ANNUAL CONFERENCE, FREEMANTLE 2020

Richter, Harald, C. Arthur, D. Wilke, S. Martin, M. Wehner, E. Ebert, M. Dunford: VALIDATION OF A PROTOTYPE WIND HAZARD IMPACT MODEL – THE APRIL 2015 DUNGOG CASE.

Richter, Harald: Operational calibrated thunder probabilities: Are we getting better?

John T. Allen, Edwina R. Allen, Harald Richter: Australian Tornadoes: Unpredictable or an evident hazard?

ASWA ANNUAL CONFERENCE

Harald Richter: Convective Forecasting in the age of the convection-allowing model (CAM). Invited talk presented at the annual conference of the Australian Severe Weather Association.

BNHCRC & AFAC CONFERENCE, 2020

Harald Richter, Craig Arthur, David Wilke, Beth Ebert, Mark Dunford, Martin Wehner: *An improved understanding of the built environment can improve forecasts of wind impact on residential buildings.* Poster presentation in lieu of the 2020 AFAC Conference.



CAWCR ANNUAL MODELLING WORKSHOP, NOVEMBER 2018

Richter, Harald, C. Arthur, D. Wilke, S. Martin, M. Wehner, M. Dunford, E. Ebert, J. Sexton and C. Mooney: THE IMPACT OF DAMAGING WINDS ON RESIDENTIAL BUILDINGS (invited).

BOM SCIENCE TO SERVICES SEMINAR SERIES

Harald Richter: NOAA's Hazardous Weather Testbed: The Spring Forecasting Experiment 2019. Seminar presented 21 August 2019.

RESEARCH ADVISORY FORUMS

Harald Richter, David Wilke, Beth Ebert, Craig Arthur, Martin Wehner, Shane Martin, Mark Dunford, Jane Sexton: Impact Forecasting for Severe Wind Events, Hobart RAF, Sep 2019.

Harald Richter, David Wilke, Beth Ebert, Craig Arthur, Martin Wehner, Shane Martin, Mark Dunford, Jane Sexton: Impact Forecasting for Severe Wind and Rain Events, Perth RAF, Jul 2019.



TEAM MEMBERS

Harald Richter: Project leader. Severe convective weather, thunderstorms and its hazards (hail, wind, tornado, heavy rain), convection-allowing modelling of severe convective weather.

Craig Arthur: Project co-leader. Tropical cyclone hazards, impact modelling
Martin Wehner: Vulnerability

Beth Ebert: Verification, ensemble prediction

Mark Dunford: Exposure (NEXIS)

David Wilke: Operational weather forecaster and project researcher

Shane Martin: Hazard Support



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APPENDIX A: SUMMARY OF DELIVERED MILESTONES DURING YEAR 3

Code	Item	Status	Comments
3.1.1.	Update wind impact forecast system and visualisation outputs based on end user workshop feedback	Complete	The 31 July 2019 end user workshop in Perth (see milestone 2.4.4) contained a detailed discussion with a range of end users of how the demonstrated wind impact forecast methodology, including its visualisation, ought to be augmented. However, there were no material suggestions for such alterations.
3.1.2.	Refined validation methodology developed and indicative results generated for the wind impact model	Completed	A very detailed and careful verification methodology has been developed based on the only viable damage dataset available to the project (20-22 April 2015, Hunter Valley). The verification report for the Dungog case is intended for later publication (not a milestone, but a worthy endeavor).
3.1.3.	Poster for BNHCRC/AFAC Conference	Completed	A short abstract, a 13-page paper and an oral presentation were produced for the 2019 AFAC conference. All of these focus on the current status and results to date of the project.
3.1.4.	Quarterly Report	Completed	
3.2.1.	Extend wind impact forecast pilot to allow multiple forecast lead times	Completed	The goal of “multiple lead times” is to ascertain how wind impact forecasts change as the model lead time decreases from ~1.5 days to only a few hours. ACCESS-City model forecasts (rather than the BARRA-SY reanalysis) will be used for this purpose.
3.2.2.	Draft for peer-reviewed	Completed	A draft of a paper that reviews quantitative impact prediction



	journal article on the wind impact prediction system highlighting issues (and their solutions) with dual-hazard impact prediction system development.		systems across the globe exists, but was rejected for publication by Weather Climate and Society. The basis for the rejection was, above all, confusion by some reviewers whether the paper was a review paper or was meant to publish our own impact prediction system which, at the time of submission in late 2018, was only in its infancy. While the draft is complete, it will require substantial work before submission (milestone 3.3.3.)+
3.2.3.	Quarterly Report	Completed	
3.3.1.	Second End User Workshop to test and appraise the updated wind impact forecasting system.	Due 30 Sep 2020 based on June 2020 Variation	The objectives for the workshop have been defined, and the list of end users to be invited has been compiled. Milestone owner is Craig Arthur.
3.3.2.	AMOS Conference Presentation.	Completed	On oral presentation was delivered to a well-attended session in Fremantle on 10 February 2020.
3.3.3.	Peer-reviewed journal article submitted.	Submission deadline set for 17 July.	As of 28 June 2020, the article is almost ready for submission, but would benefit from a range of touch-ups and a summary table which is much easier to accomplish shortly after the 'reporting season' that finished on 30 June 2020.
3.3.4.	Quarterly Report, Annual Report and Self-Assessment matrix.	Completed	Annual report is this report. QR 3 has been delivered.