

STATE EMERGENCY SERVICE



TASMANIAN STRATEGIC FLOOD MAP RINGAROOMA STUDY AREA DESIGN FLOOD MODELLING

ADDENDUM TO CALIBRATION REPORT



MARCH 2023



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ADDENDUM TO CALIBRATION REPORT MARCH 2023

Project Tasmanian Strategic Flood Map Ringarooma Study Area Design Flood Modelling	Project Number 120038
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LIST OF ACRONYMS

AEP	Annual Exceedance Probability
AMS	Annual Maximum Series
ARF	Areal Reduction Factor
ARR	Australian Rainfall and Runoff
ATP	Areal Temporal Patterns
Bureau/BoM	Bureau of Meteorology
CC	Climate Change
CFEV	Conservation of Freshwater Ecosystem Values (DPIPWE/DNRE)
CL	Continuing Loss
DEM	Digital Elevation Model
DNRE	Department of Natural Resources and Environment Tasmania (formerly DPIPWE)
DPIPWE	Department of Primary Industries, Water and Environment
DRM	Direct Rainfall Method
DTM	Digital Terrain Model
FFA	Flood Frequency Analysis
FLIKE	Software for flood frequency analysis
FSL	Full Supply Level
GIS	Geographic Information System
GEV	Generalised Extreme Value distribution
HAT	Highest Astronomical Tide
HSA	Human Settlement Area
ICM	Infoworks ICM software (Innovyze)
IL	Initial Loss
IFD	Intensity, Frequency and Duration (Rainfall)
ISIS	ISIS 2D modelling software
LiDAR	Light Detection and Ranging
mAHD	meters above Australian Height Datum
NTC	National Tide Centre
PERN	Catchment routing parameter in RAFTS
Pluvi	Pluviograph – Rain gauge with ability to record rain in real time
PTP	Point Temporal Patterns
R	Channel routing param in WMAWater RAFTS WBNM hybrid model
RAF	RAFTS Adjustment Factor
RAFTS	hydrologic model
RCP	Representative Concentration Pathways (RCPs) (CC scenarios)
RORB	RORB hydrological modelling software
SES	State Emergency Service
TUFLOW	one-dimensional (1D) and two-dimensional (2D) flood and tide simulation software (hydrodynamic model)
TP	Rainfall Temporal Patterns

1. INTRODUCTION

This report is an addendum to the Tasmanian Strategic Flood Map Ringarooma Study Area Calibration Report (WMAwater, 2023). The study area, available data, model calibration, limitations and uncertainty statements are provided in the calibration report.

This report outlines the data, methodology and the results of modelling the design flood events for the Ringarooma Study Area.

2. DATA

2.1. Previous Flood Studies

Previous flood studies in the study area were provided to WMAwater as part of the project data library. The studies that include modelling of the 1% AEP event are listed in Table 1.

Table 1: Previous flood studies

Flood study name	Study year	Study area	Report reference	Flood extents and layers available
Derby-Branhholm Flood Study (for Dorset Council)	2019	Ringarooma River (for the townships of Derby and Branhholm)	Report not available	Flood maps and layers available

2.2. Flow Data

Flood Frequency Analysis (FFA) was performed on Annual Maximum Series (AMS) at Ringarooma River @ Moorina gauge (Table 2). The other gauges in the study area were not included in the FFA analysis due to insufficient record length, inconsistent datasets and/or unreliable rating curves. More detail on the quality of the gauge data is provided in the calibration report (WMAwater, 2023).

Table 2: Flow gauges used for FFA

Gauge number	Gauge name	River	Period of record	Number of points in AMS
30-2	Ringarooma River @ Moorina	Ringarooma River	1978 - 2020	42

2.3. Design Inputs

The design inputs used in the study (Intensity Frequency Duration (IFD) depths, losses, pre-burst rainfalls, Areal Reduction Factors (ARFs) and temporal patterns) were obtained through the ARR Data Hub (Babister et al, 2016) and the Bureau of Meteorology website (Bureau of Meteorology, 2019).

2.3.1. Design Rainfall Depths and Spatial Pattern

Intensity Frequency Duration (IFD) information was sourced from the Bureau of Meteorology website (Bureau of Meteorology, 2019). IFD information was sourced for each individual sub-catchment to give a spatial pattern across the study area. Examples of sub-catchment rainfalls are shown in Figure A 1 to Figure A 3.

2.3.2. Temporal Patterns

ARR 2016 Book 2 Chapter 5 (Ball et. al. 2019) recommends the use of areal temporal patterns for catchments with areas greater than 75 km². Therefore, for the flood frequency analysis, the areal temporal patterns relevant to this location were downloaded from the ARR Data Hub. An example of the temporal patterns downloaded from the Data Hub is shown in Figure A 4.

For selection of the final design runs applicable to the entire study area, areal and point temporal patterns were downloaded from the ARR Data Hub. Temporal patterns were filtered for embedded bursts and in some cases patterns with large, embedded bursts causing significant outliers were removed. When assessing the reference critical flow for each sub-catchment (as described in the Hydrology Methods Report), point temporal patterns were used for sub-catchments with an upstream area of less than 75 km² and to assess shorter storms if the critical duration on a larger catchment was identified as 12 hours (the shortest duration available with areal temporal patterns).

2.3.3. Pre-burst

Pre-burst rainfall depths were taken from the ARR Data Hub as a ratio of the IFD depths. As Initial Losses (ILs) calibrated to the FFA were greater than zero, there was no need to include sensitivity to adding a pre-burst temporal pattern for this study area, as the pre-burst has effectively been removed from the IL with some IL depth remaining.

2.3.4. Losses

Initial values for sub-catchment IL and Continuing Loss (CL) were derived from the unpublished Hydrologic Soil Groups of Tasmania data that was provided for use in this project (DPIPWE 2019).

2.3.5. Baseflow

Baseflow was calculated for each calibration event and was found to be less than 5% of the event peaks. In line with ARR 2016 Book 5 Chapter 4 (Ball et. al. 2019), where baseflows of less than 5% are considered a small component compared to runoff, a simplified approach to baseflow calculations was undertaken. Hydrodynamic modelling of the calibration events showed that large flood events in this study area were peak rather than volume driven. Baseflows will be a small component of the hydrograph for the AEPs of interest (2%, 1% and 0.5%) and therefore baseflow was not included in the design events.

2.3.6. Direct Rainfall

Two hour direct rainfall storms were created using each sub-catchment's IFD depths using the method described in the Hydrodynamic Methods Report (WMA 2020b).

2.3.7. Climate Change

2.3.7.1. Rainfall Factors

Climate change factors for the study area were downloaded from the ARR Data Hub. ARR recommends the use of the RCP4.5 and RCP8.5 values, however the Tasmanian Interim Planning Scheme recommends the use of RCP8.5 and this has been adopted for this project. RCP8.5 results for the year 2090 give a rainfall scaling factor of 16.3% to be applied to the IFDs.

2.3.7.2. Boundary Conditions

Sea level rise was included in the climate change scenario and was applied at the downstream boundary of the hydrodynamic model. The rise in water level was taken from the Tasmanian Local Council Sea Level Rise Planning Allowances, which uses sea level rise projections based on RCP 8.5 for 2100. This gave a rise in sea level of 0.84 m for the Dorset Council area.

The levels from this document were deemed most appropriate to be consistent with best practise planning around Tasmanian Councils.

3. OVERVIEW OF METHODOLOGY

The hydrological and hydrodynamic design modelling methodology was outlined in the Hydrology Methods Report (WMAwater, 2021a) and the Hydrodynamic Methods Report (WMAwater 2023). Details on the methods are only included in this report where they deviate from the methods described in these reports or are specific for this catchment.

The modelling method for the design events includes the following steps.

- Data preparation
 - Fitting FFA to suitable flow records
 - Extraction of design data – IFDs, temporal patterns, pre-burst rainfalls from ARR DataHub (automated in the modelling process), derivation of direct rainfall storms
- Hydrologic modelling
 - Identification of flow gauge locations
 - Identification of dam and diversion locations
 - Sub-catchment delineation
 - Include dam storage and spillway ratings where required
 - Event calibration for PERN parameter and event losses, using automated WMAwater RAFTS modelling tool, IDW rainfall surfaces and available flow data.
 - Output event sub-catchment rainfalls, routing parameters and event losses for input to hydraulic model
 - Calibration of design losses to FFA using automated WMAwater RAFTS model
 - Run design events in WMAwater RAFTS modelling tool, with design data, calibrated routing parameters and design losses. Outputs design sub-catchment rainfalls for input to hydrodynamic model.
- Hydrodynamic modelling
 - Run design events and direct rainfall through the calibrated hydrodynamic model with the applicable downstream boundary levels and dam initial conditions.
 - Output design event and direct rainfall results for processing.
- Mapping
 - Convert design event and direct rainfall results to a grid format with a grid resolution of at least 10 m.
 - Envelope design event results to produce the maximum envelope of the inputs.
 - Filter direct rainfall results using a peak flood depth filter of 0.1 m. Clip direct rainfall results to the design event envelope.
 - Map the design event envelope and filtered direct rainfall results.

4. CALIBRATION OF DESIGN LOSSES

FFA was undertaken at the gauges identified in Table 2. The results of the FFA are shown in Figure 1. The fitting method and distribution that provided the best fit to the data at the gauge site is shown in Table 3.

Table 3: Fitting method and distribution used for FFA

Gauge number	Gauge name	Fitting method	Distribution
30-2	Ringarooma River @ Moorina	Bayesian	Log Pearson III

The calibrated external hydrologic model for each study area was run through the solver and the initial and continuing losses that best matched the FFA were estimated. As the events of relevance to this study are of 2% AEP or larger, the results were weighted to this end of the FFA curve. The catchment-average continuing loss was distributed across the study area using the hydrological soil group final infiltration rates.

The percentage differences between the FFA and the modelled peak flow for the 2% and 1% AEP events are shown in Table 4. The modelled data provided a good fit to the FFA 1% and 2% AEP peak flows.

Table 4: FFA and modelled peak flows

	Ringarooma River @ Moorina	
Parameter	2% AEP	1% AEP
FFA peak flow (m ³ /s)	421	536
Modelled peak flow (m ³ /s)	427	524
Peak flow difference (%)	1%	-2%

The adopted loss values are shown in Table 5, and the comparison to gauge FFA is shown in Figure 1.

Table 5: Adopted losses

Initial Loss (mm)	Continuing Loss (mm/h)		
	Soil Type A	Soil Type B	Soil Type D
2	6.8	3.5	0.8

5. DESIGN EVENT MODELLING

5.1. Design Event Selection

Design inputs were run through the calibrated hydrological model across the entire study area with a range of ARFs to select representative ARFs, storm durations and temporal patterns to be run through the hydrodynamic model. The selected storms and the number of sub-catchments best represented by each are shown in Table 6. The temporal patterns for each selected run are shown in Figure 2 and Figure A 4.

Storms with smaller ARF bins are not valid for the main river with large accumulated upstream areas, as rainfalls have not been adjusted down by an appropriate ARF. In initial runs some ARF-duration-TP sets with small ($\leq 45\text{km}^2$) ARFs were being selected along the main river, in areas with a large upstream catchment area ($>45\text{km}^2$). Therefore, for the model runs with an ARF bin of 45 km^2 or less, the main river sub-catchments (upstream areas $> 45\text{ km}^2$) were assigned 0 mm rainfall. This means the smaller ARF sets did not drown out the more appropriate sets along the main river. The resulting selected patterns were reviewed to ensure no pattern with 0 rainfall was selected in sub-catchments where 0 rainfall was applied.

Table 6: Selected storms for each AEP with the number of sub-catchments best represented by each set

AEP	Storm duration (min)	ARF bin	# sub-catchments
2%	270	25	22
2%	540	250	45
2%	720	45	19
2%	1440	1200	20
1%	270	25	21
1%	540	250	43
1%	720	45	19
1%	1440	1200	23
0.5%	270	25	21
0.5%	540	250	48
0.5%	720	45	15
0.5%	1440	1200	22

Diagram 1 shows the ARF-duration-TP set used to give representative flows for each sub-catchment for the 1% AEP event. Headwater sub-catchments where only direct rainfall is applied are also shown. In the headwater catchments, direct rainfall was defined as the dominating event, with the rainfall intensities factored to account for losses via a runoff coefficient. For this study area, a runoff coefficient of 65% was adopted. Although direct rainfall is applied to all sub catchments, the mapping process detailed in Section 3 ensures that primary flow paths are not defined by this event.

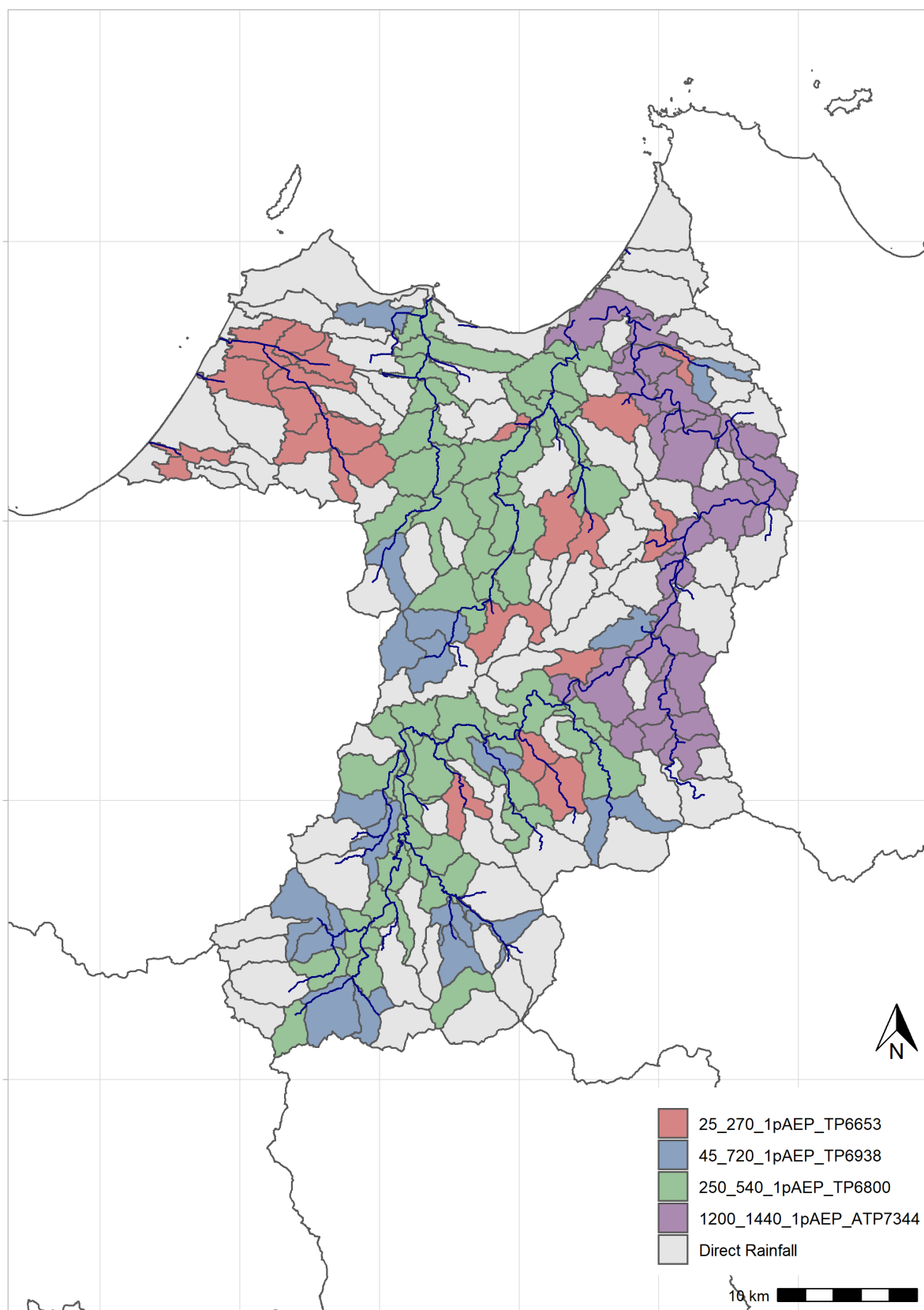


Diagram 1: ARF set relevant for each sub-catchment for the 1% AEP event

The selection of four ARF-duration-TP sets per AEP does introduce errors when compared to running the ideal ARF-duration-TP set through the hydrodynamic model for each sub-catchment, however running thousands of runs of the hydrodynamic model is not computationally feasible. The percentage errors for each sub-catchment are shown in Figure B 1 to Figure B 3, and a summary of the magnitude of the errors is shown in Table 7. Each sub-catchment's absolute percentage error is calculated using the following equation:

$SC_Q_Peak_{ref}$ = Sub-catchment peak flow run with ARF from that sub-catchment's ARF bin, with critical duration calculated at this gauge, and TP above the mean selected.

$SC_Q_Peak_{sel}$ = Sub-catchment peak flow run with ARF, storm duration and TP from the selected pattern as shown in Diagram 1

$$\text{Absolute subcatchment percentage error} = \left| \frac{(SC_Q_Peak_{sel} - SC_Q_Peak_{ref})}{SC_Q_Peak_{ref}} \right| \times 100$$

Table 7: Sub-catchment errors using the ARF-TP-duration sets shown in Table 6 for each AEP

AEP	Absolute sub-catchment error		
	Mean across sub-catchments	90 th %ile across sub-catchments	Max of all sub-catchments
2%	3.8%	7.6%	18.4%
1%	3.7%	7.8%	20.2%
0.5%	3.5%	7.5%	14.0%

The selected storms and direct rainfall were then run through the calibrated hydrodynamic model (as documented in the calibration report). For the design event modelling, a static tailwater level set to highest astronomical tide was adopted for the downstream boundary. This data was provided by the National Tide Centre (NTC) in 5 km² grid cells, and the mean value of these grid cells within the study area was used.

Table 8 below summarises the downstream boundary levels and dam initial conditions for each design event.

Table 8. Downstream boundary levels and dam initial conditions for each AEP

AEP	Downstream boundary	Cascade Dam	Dunns Creek Dam	Frome Dam
2%	HAT (1.61 mAHD)	FSL (341.73mAHD)	FSL (297.31 mAHD)	FSL (327.475 mAHD)
1%				
0.5%				
1% CC	HAT + sea level rise (2.45 mAHD)			

5.2. Design Event Results

The results of the design event modelling are shown in Figure 3 to Figure 18 in terms of peak flood level, depth, velocity, and hydraulic hazard for the 2%, 1%, 1% CC, and 0.5% AEP design events. The results shown are of the design event envelope and filtered direct rainfall results, as detailed in Section 3. A critical event plot for the 1% AEP design event is provided in Figure 19.

For direct rainfall only, in some areas the peak flow for headwater catchments was found to be higher in the hydrodynamic model than in the external hydrologic model. This was most significant in headwater catchments with high slopes. To ensure that the overestimation of these peak flows in the headwater catchments would not impact the design results, the direct rainfall results were clipped to the headwater catchments before the envelope of the design runs and direct rainfall was calculated.

5.2.1. Review of Results at Ringarooma River at Moorina

A review of the design flows produced from the hydrodynamic model at Ringarooma River at Moorina gauge was undertaken, comparing to the flows derived from the FFA (Table 9).

Table 9: Design flows at Ringarooma River at Moorina

Parameter	2% AEP	1% AEP	1% AEP CC	0.5% AEP
Modelled peak flow (m ³ /s)	451	524	648	635
FFA peak flow (m ³ /s)	421	536	n/a	675
Peak flow difference (%)	+7%	-2%	n/a	-6%

5.2.2. Comparison to Previous Flood Studies

Dorset Council commissioned Hydrodynamica to undertake a flood mapping exercise for the townships of Branxholm and Derby in 2018-19. Although the flood maps were able to be sourced from the Council website, the report was not provided for the current study.

From the flood maps an estimation of the 5%, 2%, 1%, and 1% CC AEP levels for Ringarooma River from Branxholm to Derby were able to be established. It is understood that the design levels were derived from a 2D ISIS hydrodynamic model (using inflows derived from an FFA and RORB hydrologic model to Ringarooma River at Moorina). It is noted that the peak flows derived from the FFA presented in the 2018-19 study are greater than in the present study (1% AEP flow of 603 m³/s compared to 536 m³/s).

The estimated design levels between the 2018-19 study and the present study for the 2% and 1% AEP design events are compared in Table 10.

Table 10. Design levels along Ringarooma River (mAHD)

Comparison Point	2% AEP			1% AEP		
	2018-19 Study	Present Study	Difference (m)	2018-19 Study	Present Study	Difference (m)
A	175.65	175.64	-0.01	175.84	175.74	-0.10
B	148.88	150.28	1.40	149.26	150.74	1.48

There appears to be a reasonable match in the estimated design levels between the 2018-19 study and the present study, other than through Derby where the 1% AEP design in the present study is higher than the 2018-19 study. This is of note as the peak flows derived from the FFA to Moorina in the present study are lower than the 2018-19 study. Without the 2018-19 flood study report, it is not possible to determine the details of the data and assumptions that have been used to generate the flood levels, so the reasons for these differences are not known.

Diagram 2 and Diagram 3 show comparisons of the modelled flood extent for the 1% AEP design event between the 2018-19 study and the present study. No significant differences were noted other than an area to the north east of Derby that is flooded in the current study modelling, and was not flooded in the 2018-19 study.

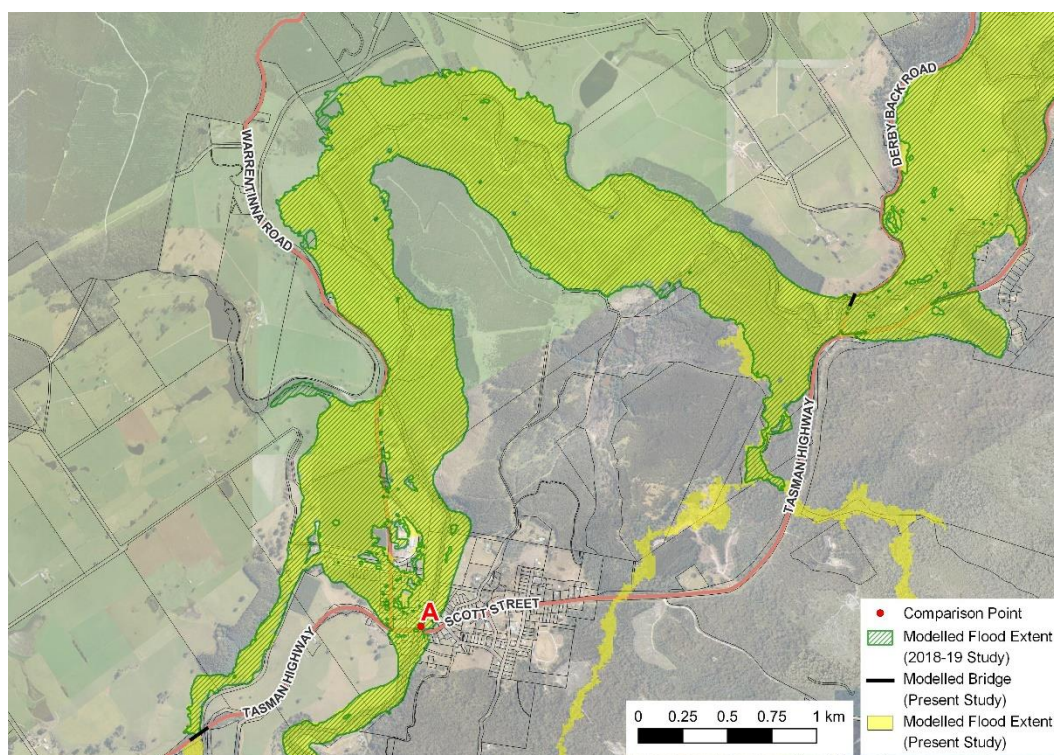


Diagram 2. Modelled flood extent for the 1% AEP design event (Bransholme)

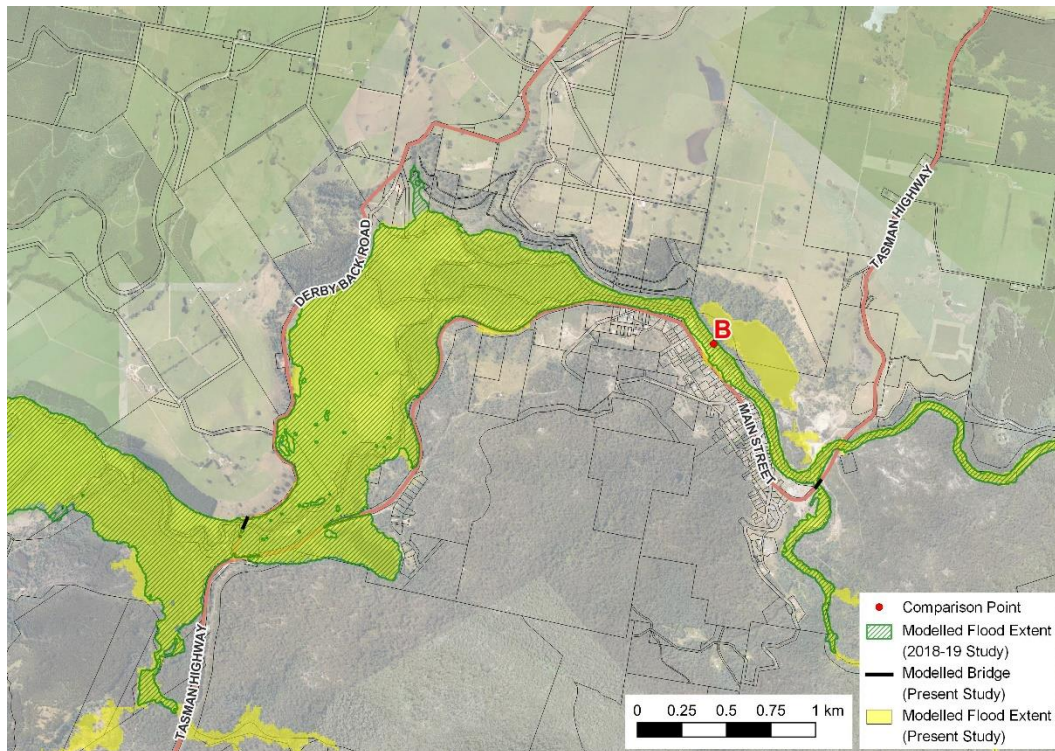


Diagram 3. Modelled flood extent for the 1% AEP design event (Derby)

6. LIMITATIONS

A detailed uncertainty assessment of the data, hydrological calibration and hydrodynamic model is contained in the Ringarooma Calibration Report (WMAwater 2023). There are additional limitations relating to the design modelling methodology.

The selection of limited duration-TP-ARF sets introduces some errors across the catchment as described in Section 5.1. This is appropriate for a regional method, however site-specific ARFs, critical durations and TP selection should be used for detailed design modelling at specific locations.

As discussed in Section 5.2 there is some uncertainty introduced by the direct rainfall application on the headwater catchments. While the method used is appropriate for broad scale mapping, a full design event assessment should be undertaken for any future focussed studies in this area.

7. REFERENCES

Babister, M., Trim, A., Testoni, I. & Retallick, M (2016): The Australian Rainfall & Runoff Datahub 37th Hydrology and Water Resources Symposium Queenstown NZ, 2016 available at <http://data.arr-software.org/>

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (2019): Editors Australian Rainfall and Runoff: A Guide to Flood Estimation Commonwealth of Australia, Australia, 2019

Bureau of Meteorology (2020): Rainfall Map Information. Bureau of Meteorology, Victoria, Australia URL: <http://www.bom.gov.au/climate/austmaps/about-rain-maps.shtml>

Bureau of Meteorology (2019): 2016 Rainfall IFD Data System. Bureau of Meteorology, Victoria, Australia URL: <http://www.bom.gov.au/water/designRainfalls/revised-ifd/>

DPIPWE (2019): Hydrologic Soil Groups of Tasmania (Unpublished). Department of Primary Industries and Water, Hobart, Tasmania. Created March 2019

WMAwater (2020a): Tasmanian Strategic Flood Map Hydrology Methods Report, November 2020. Report for State Emergency Service, Tasmania.

WMAwater (2020b): Tasmanian Strategic Flood Map Hydrodynamic Model Methods Report, November 2020. Report for State Emergency Service, Tasmania.

WMAwater (2021a): Tasmanian Strategic Flood Map Hydrology Methods Report - Addendum, May 2021. Report for State Emergency Service, Tasmania.

WMAwater (2023): Tasmanian Strategic Flood Map Ringarooma Catchment Model Calibration Report, March 2023. Report for State Emergency Service, Tasmania.



FIGURE 1

Subcatchment: Rng98

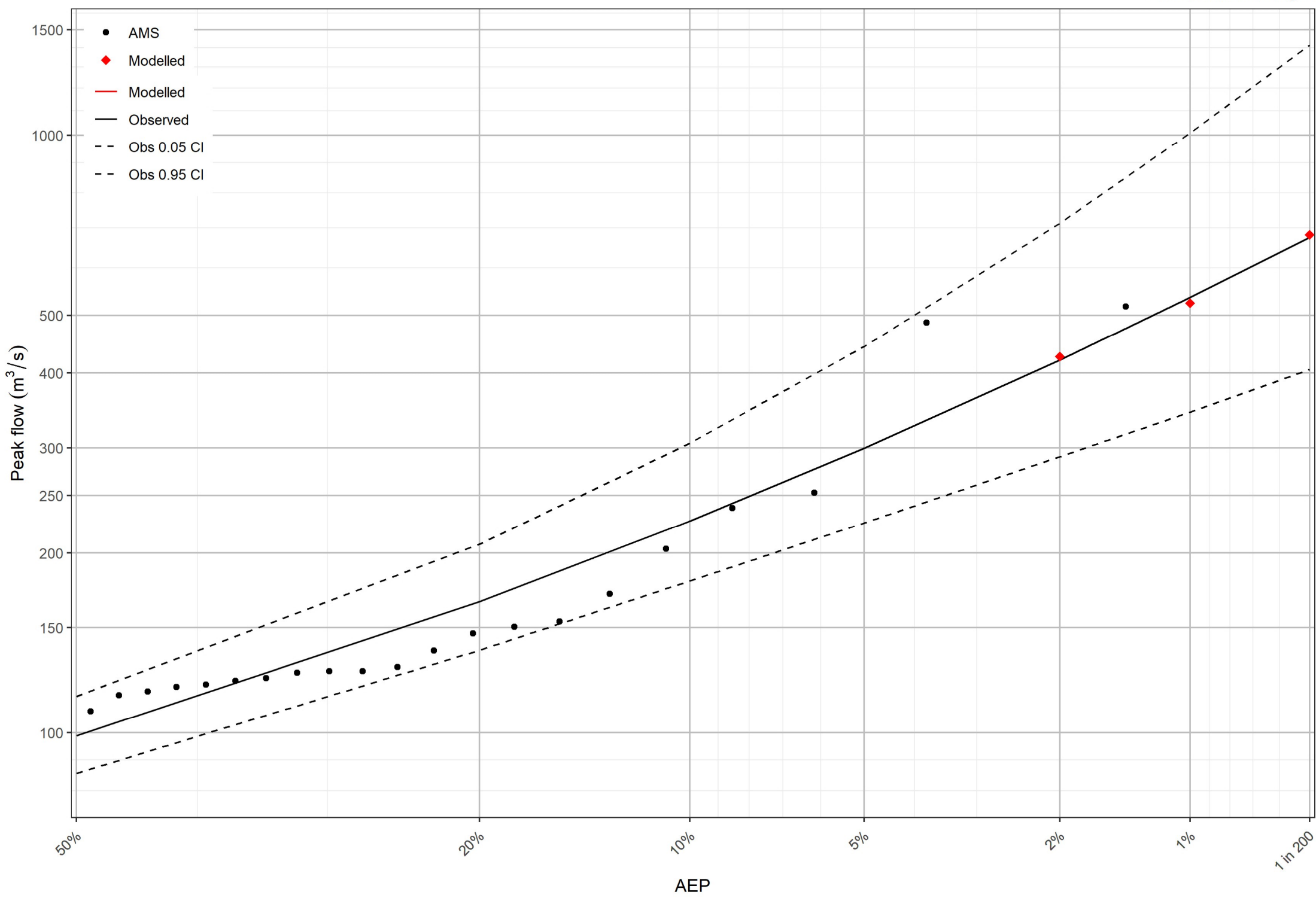
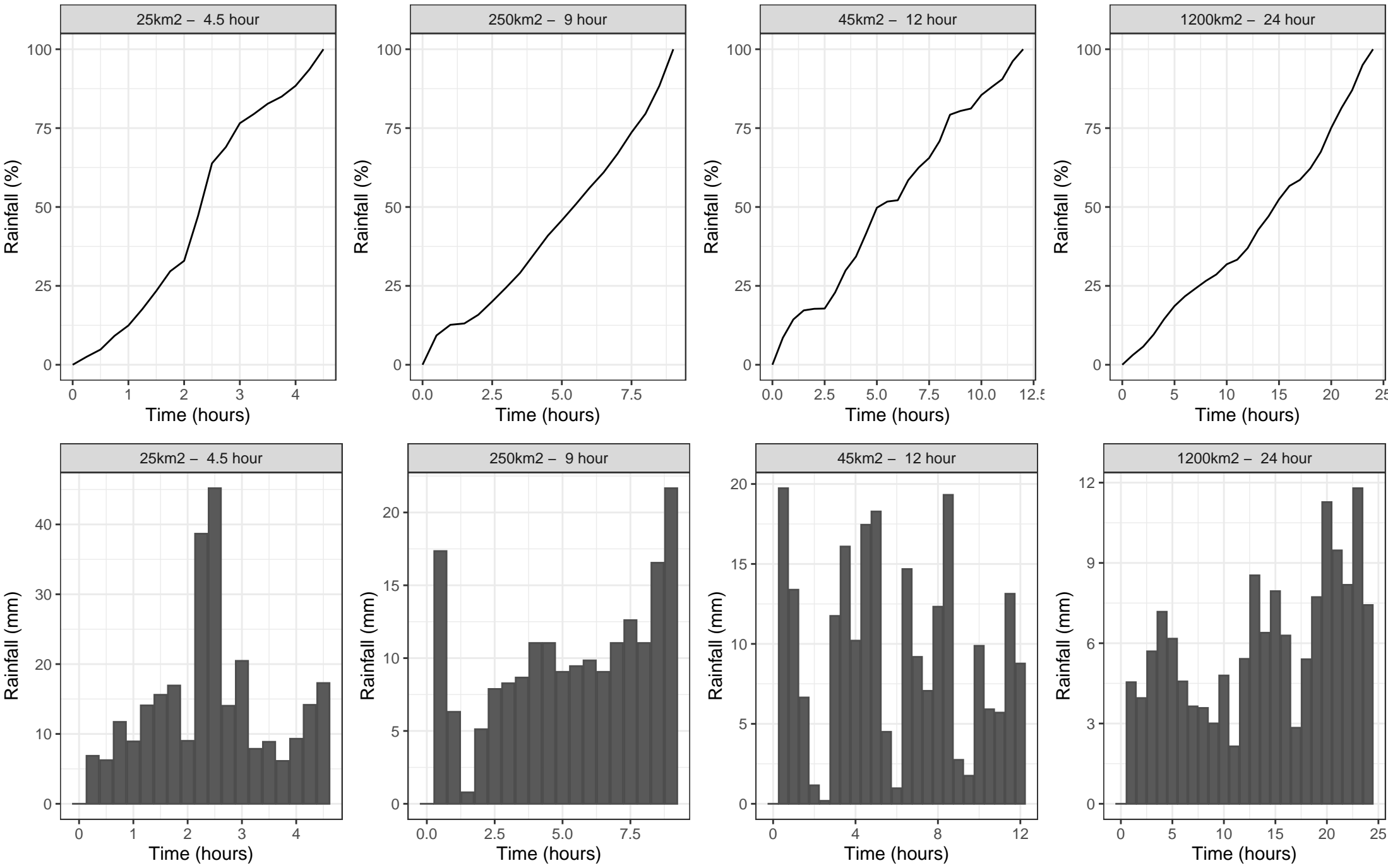
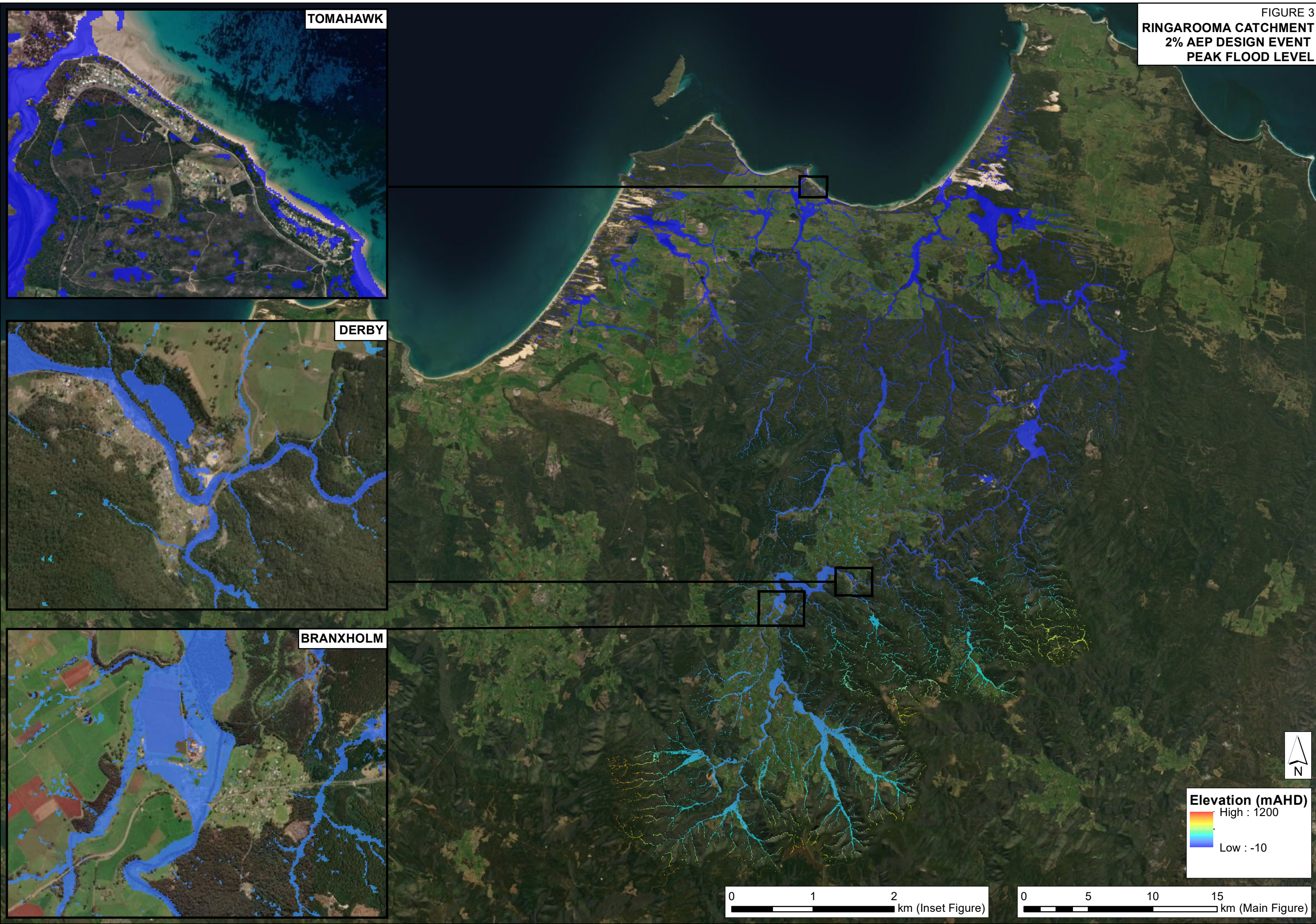
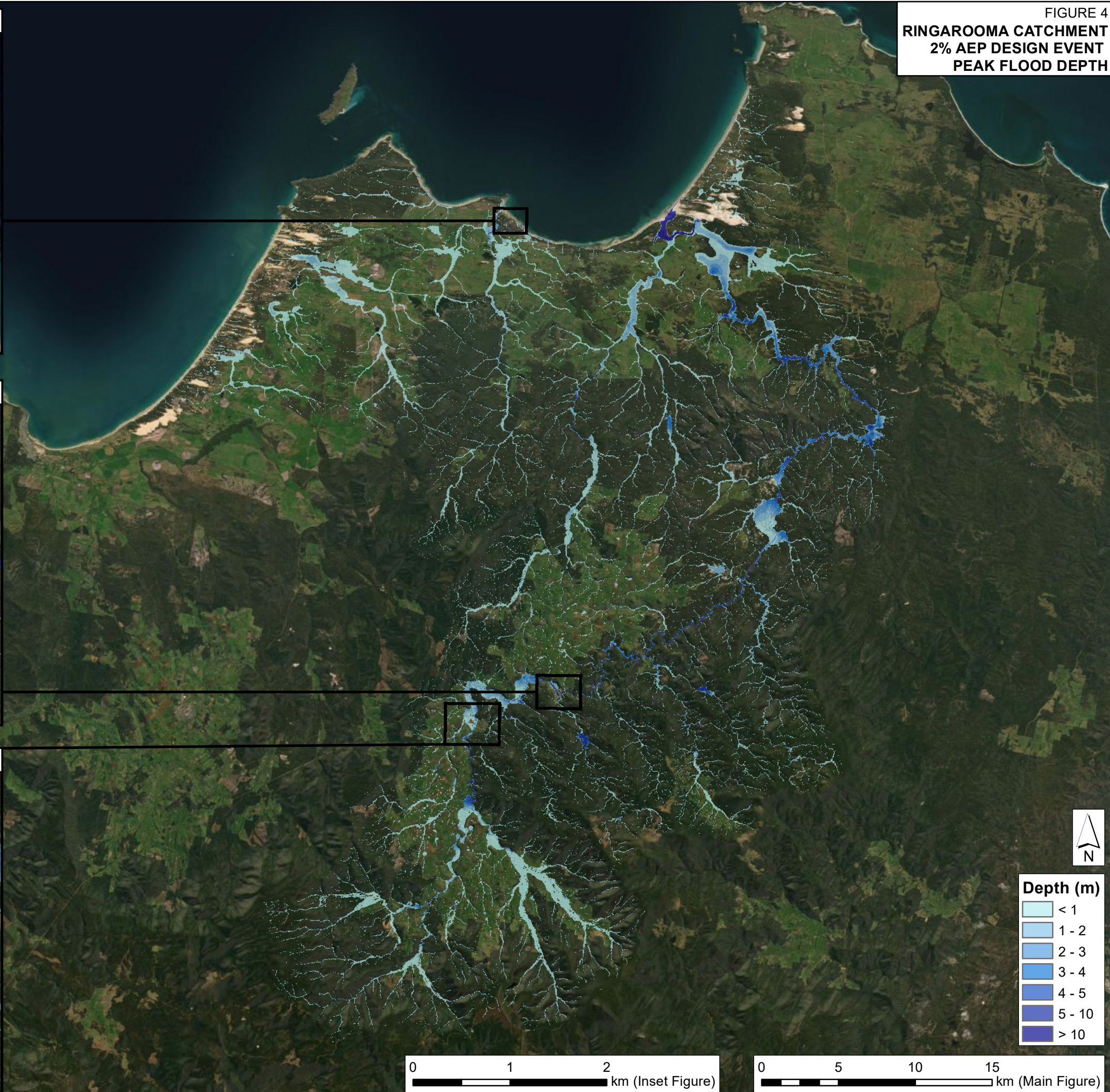
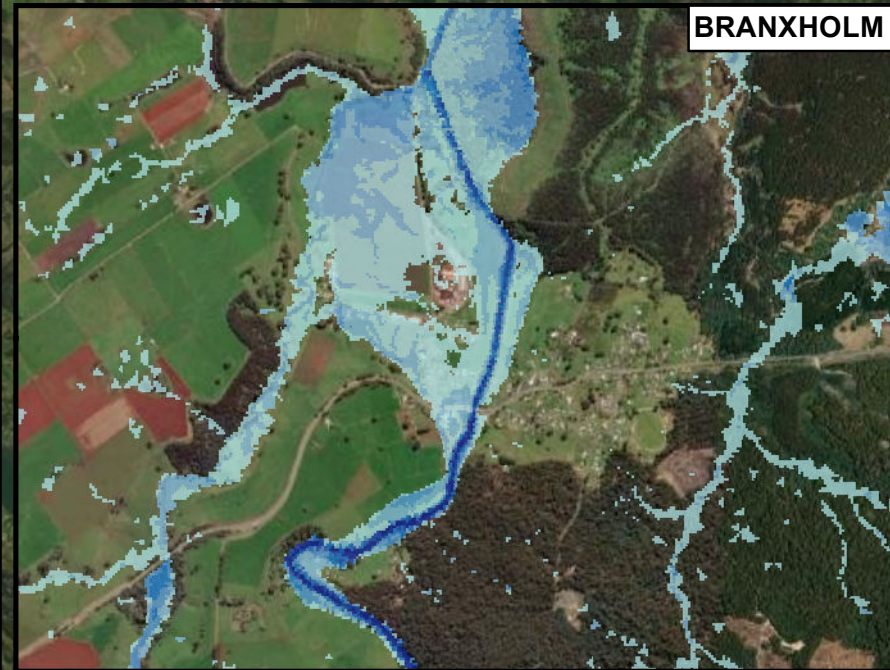
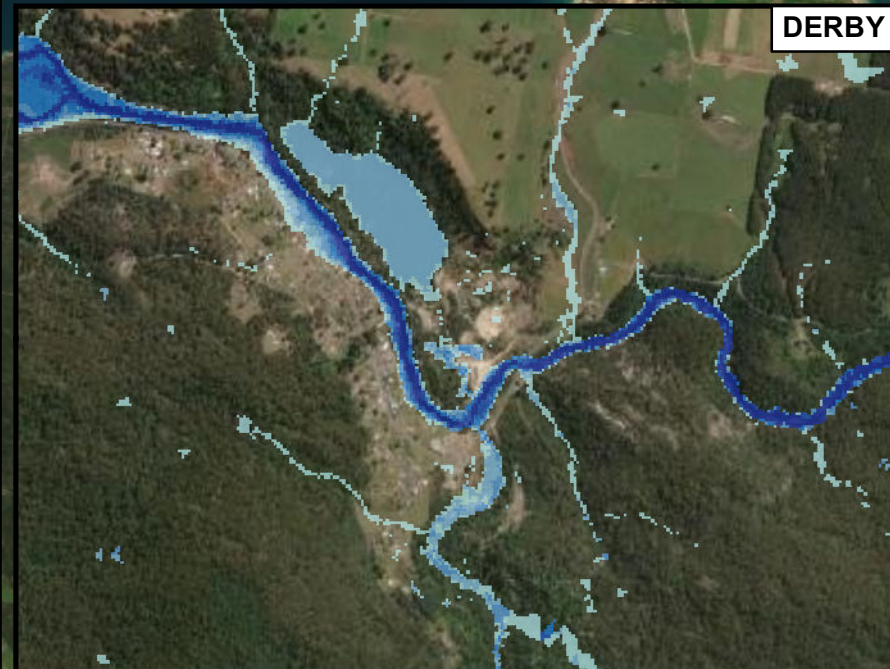


FIGURE 2
SELECTED DESIGN TEMPORAL PATTERNS ALL AEPS
BY STORM DURATION AND ARF AREA

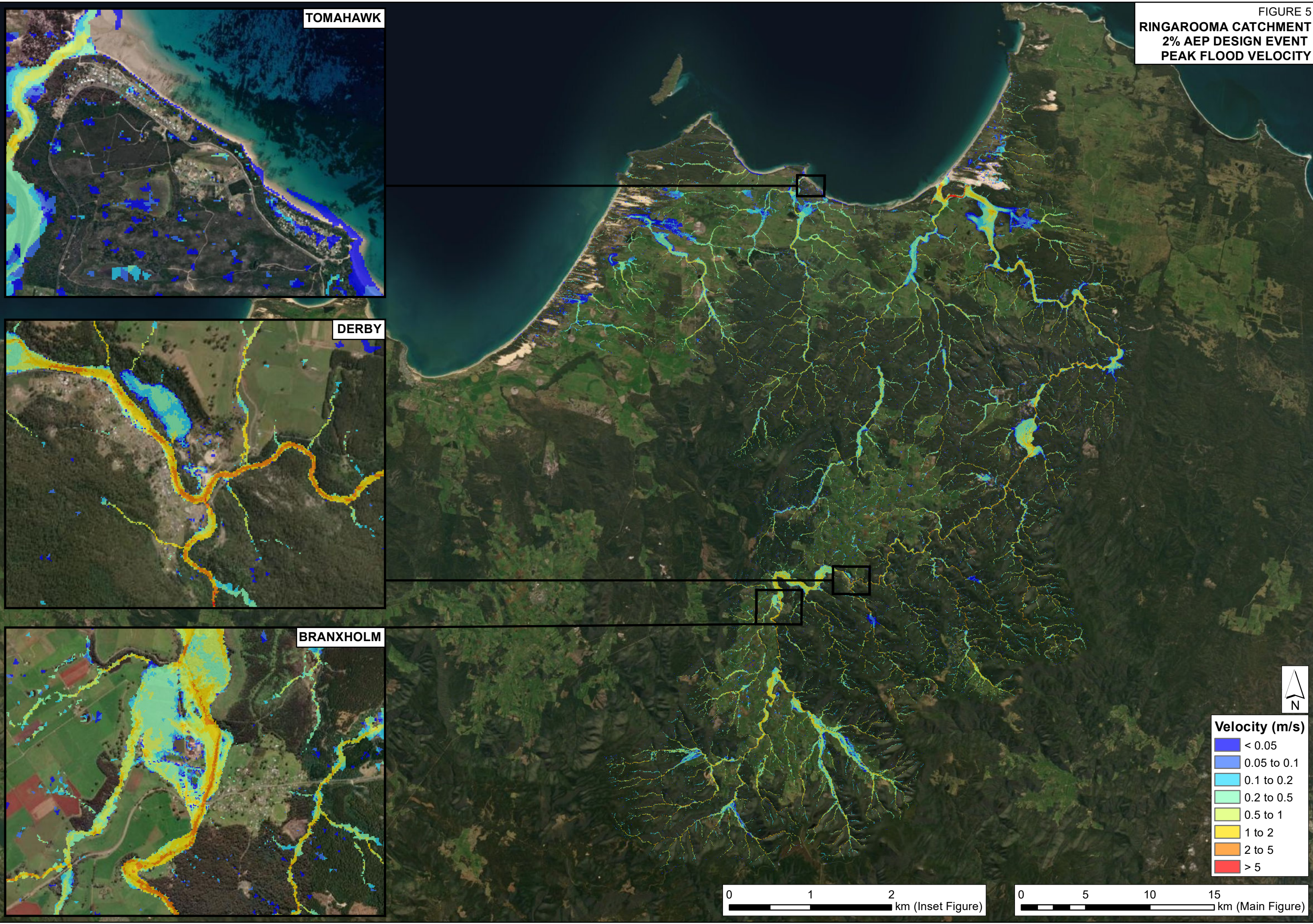


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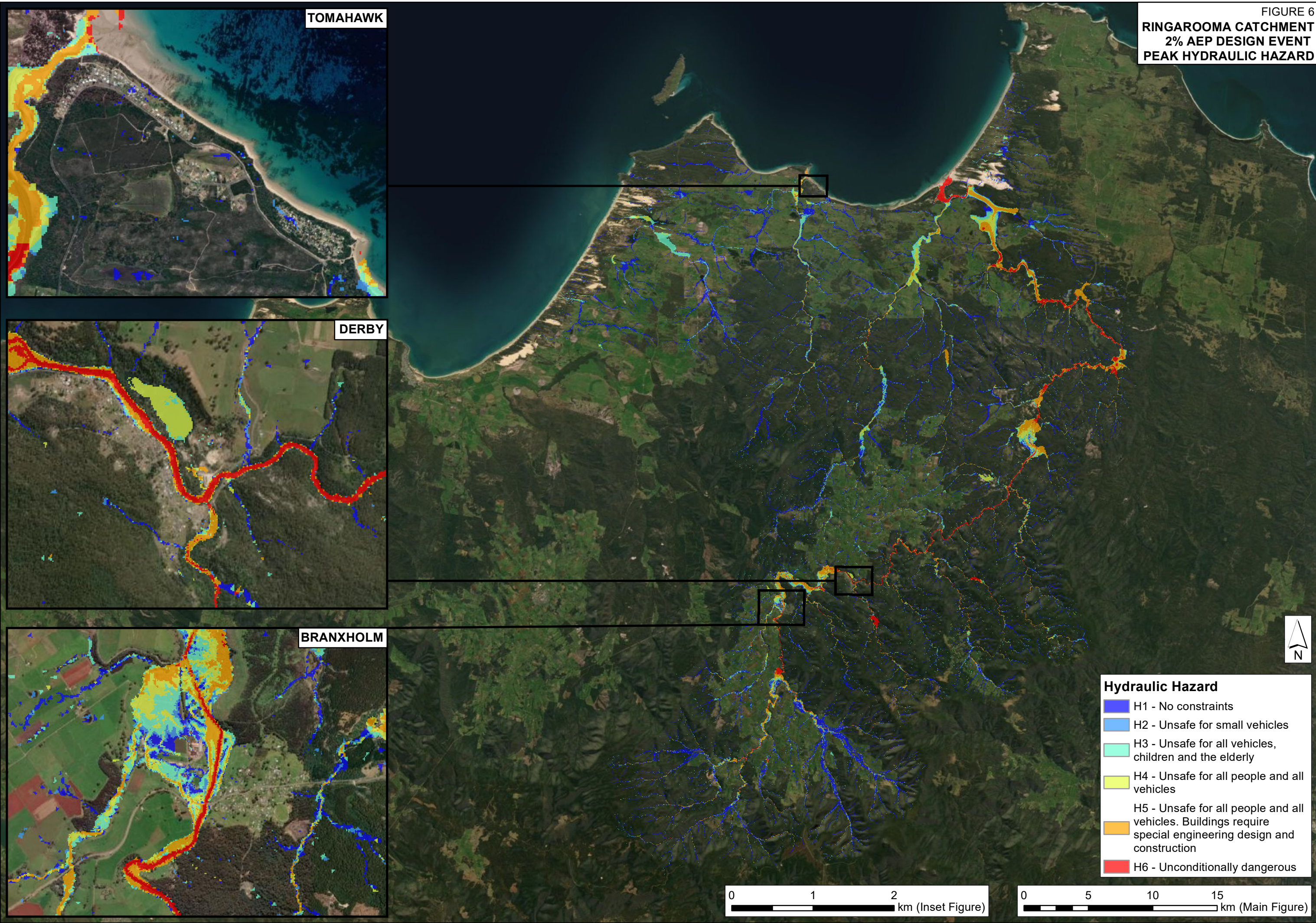


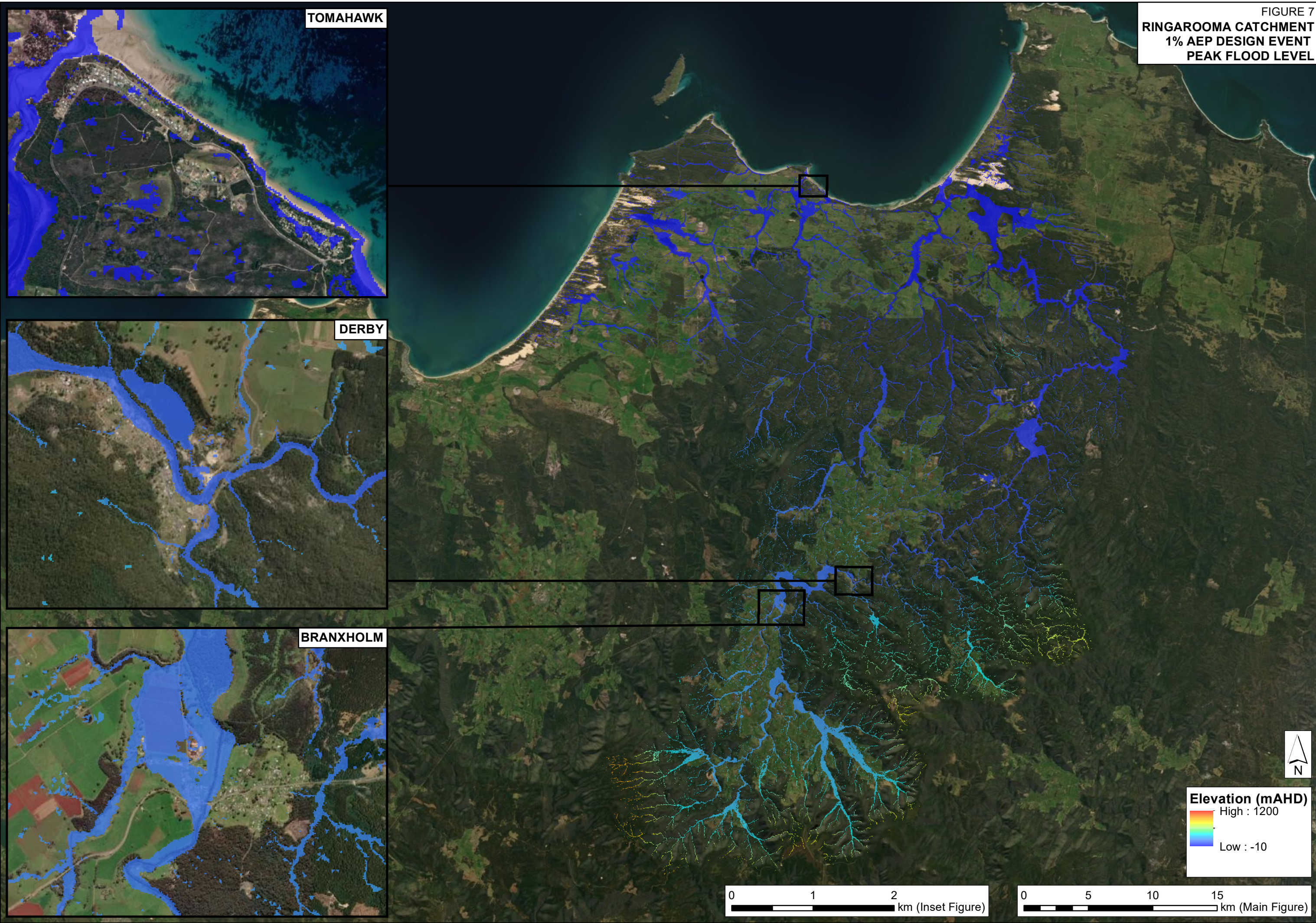


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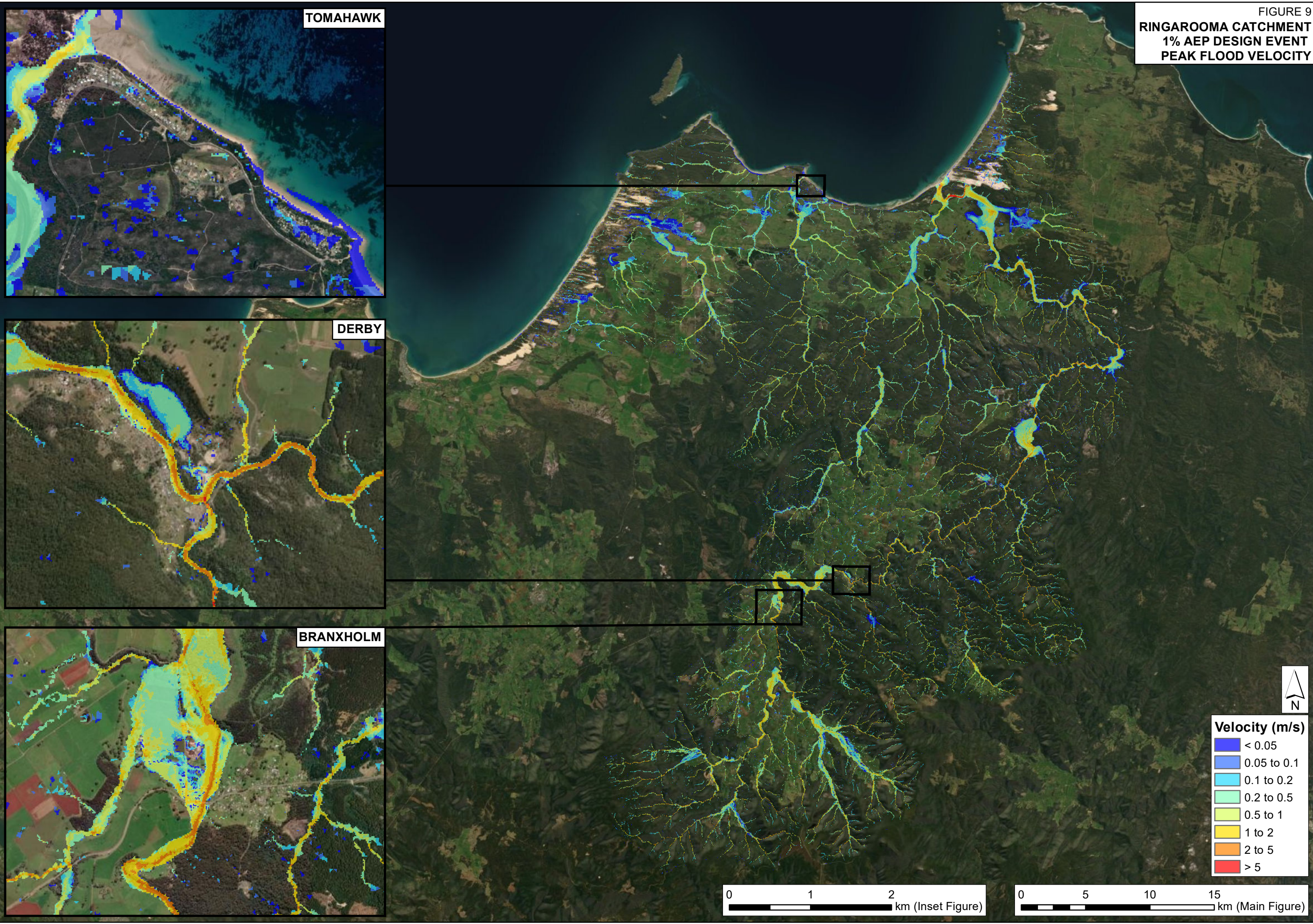
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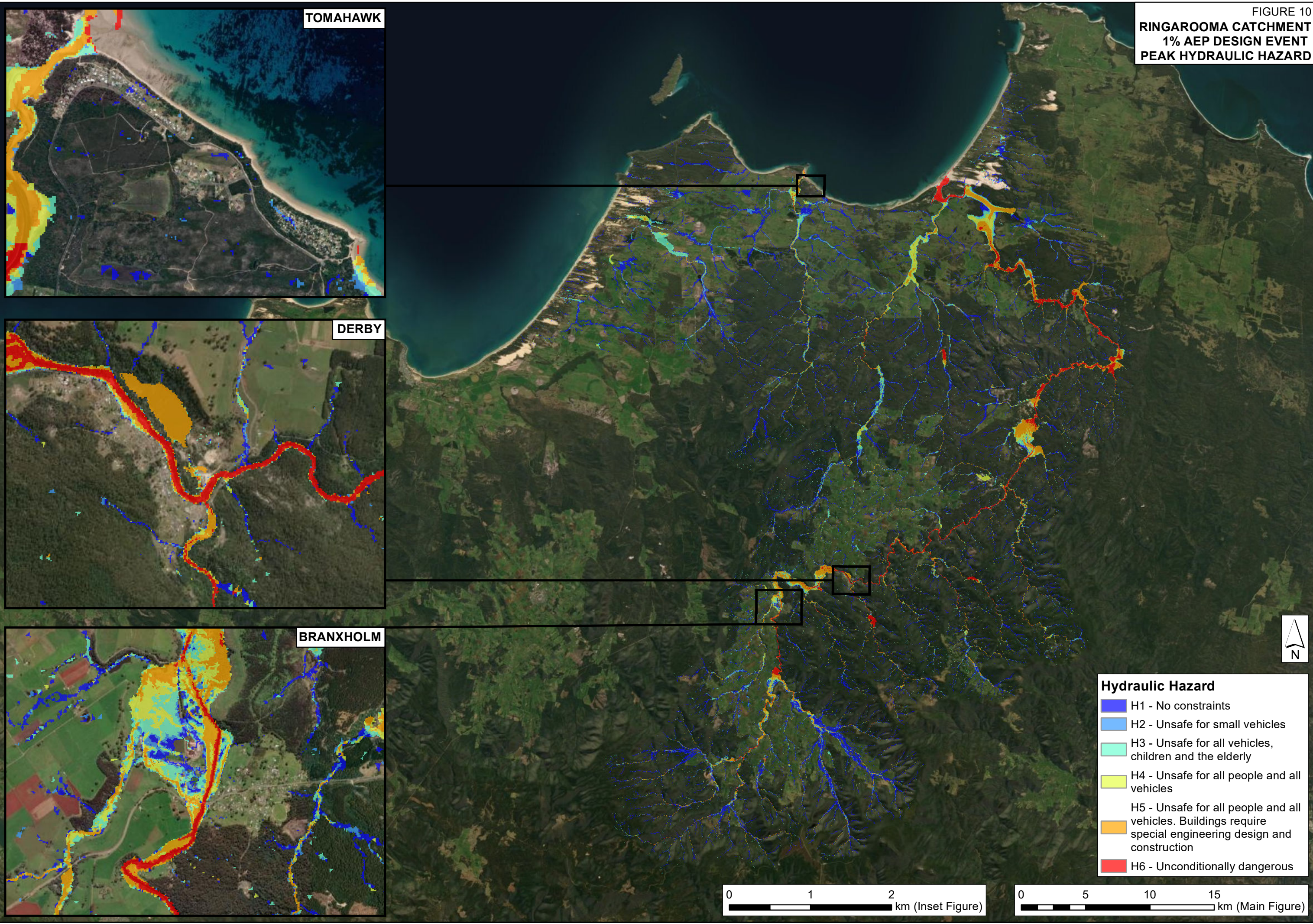


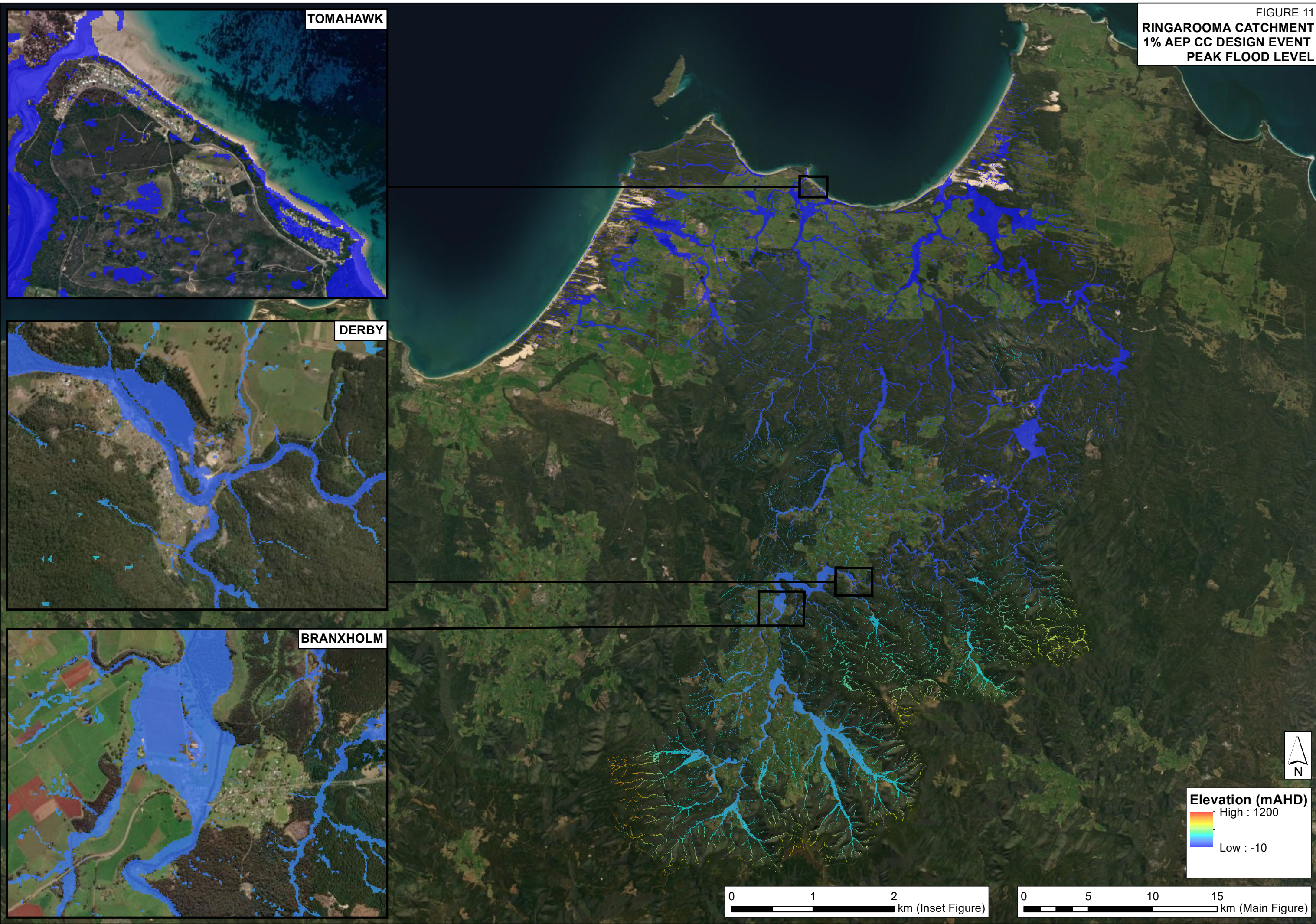


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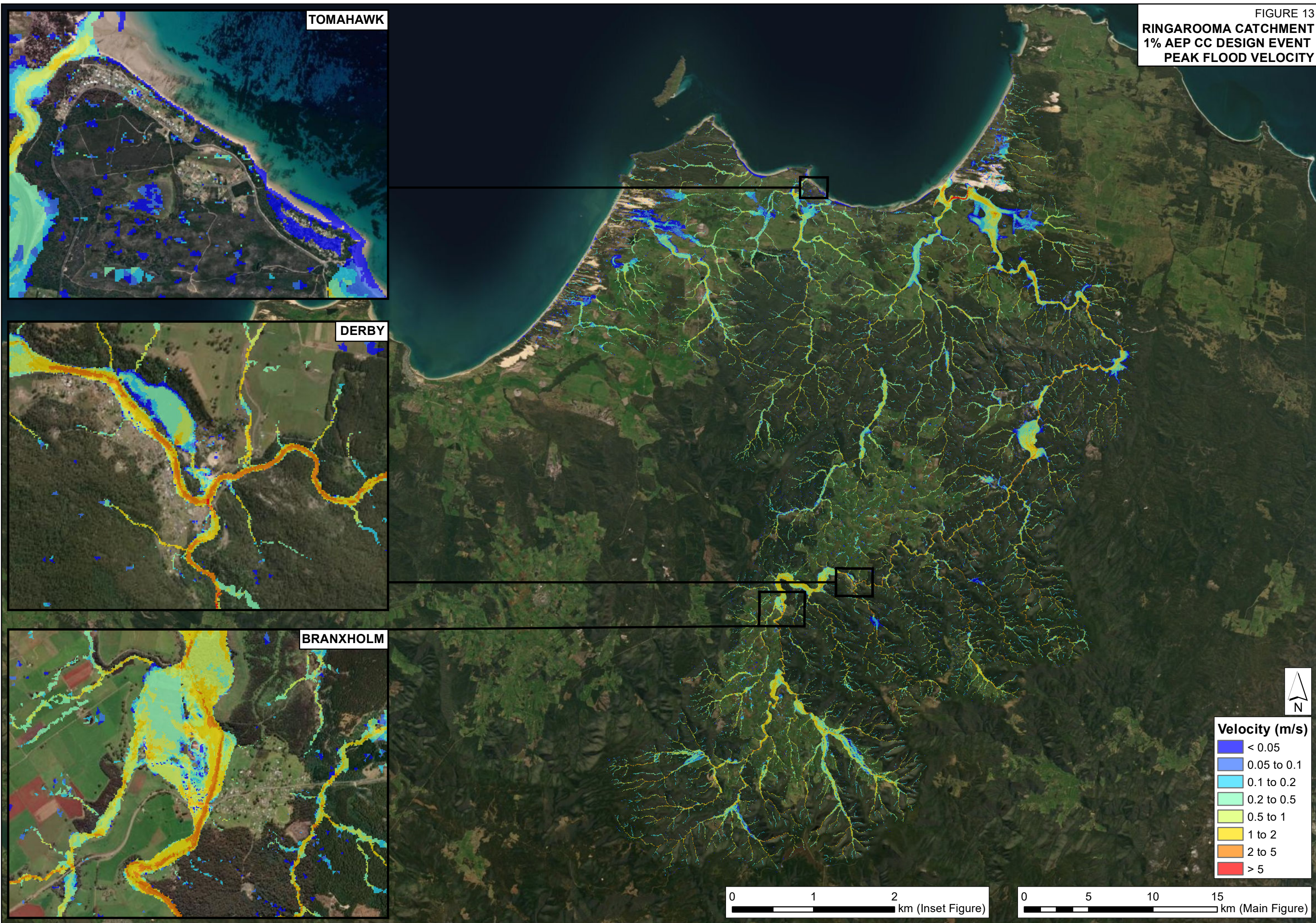




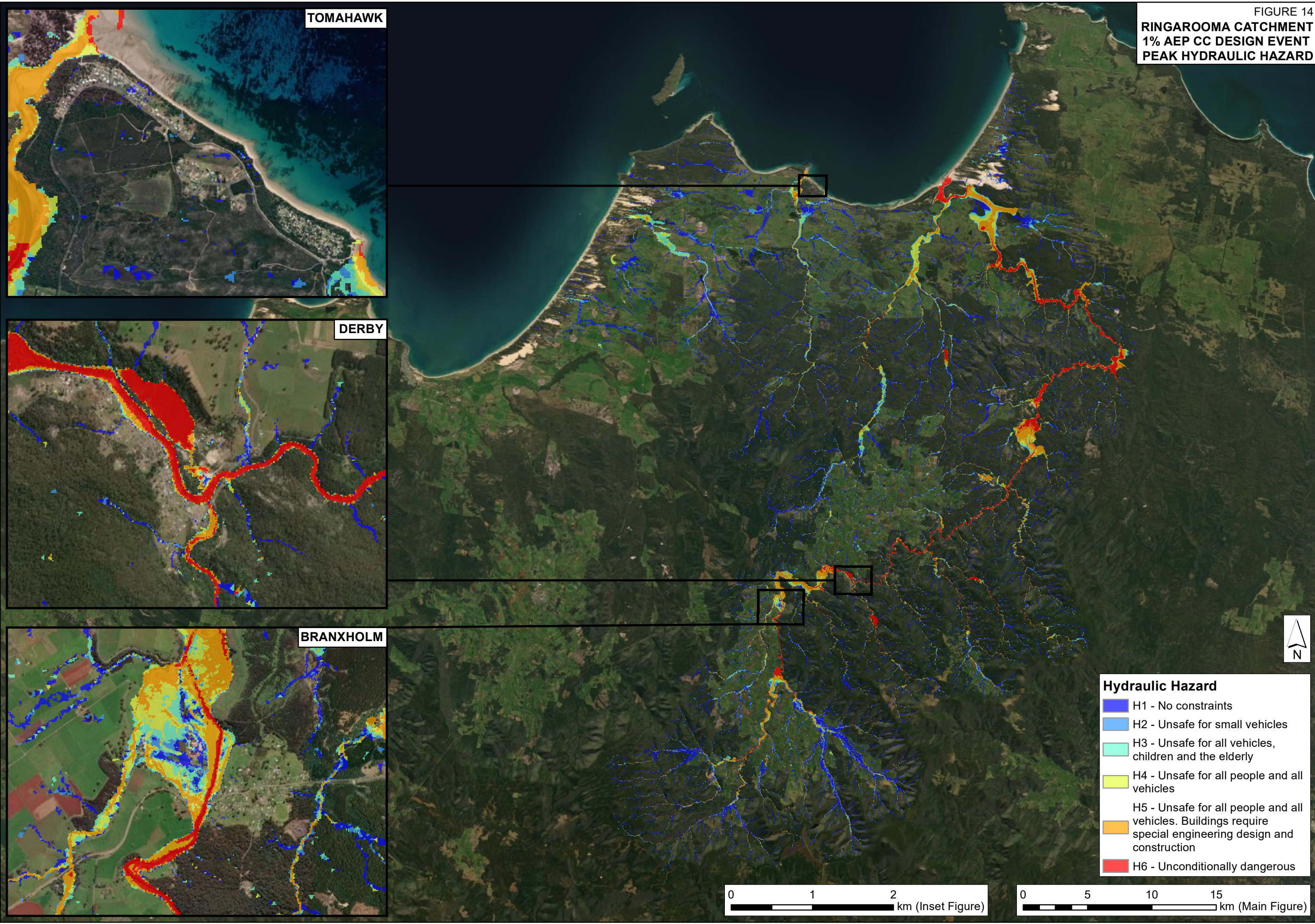
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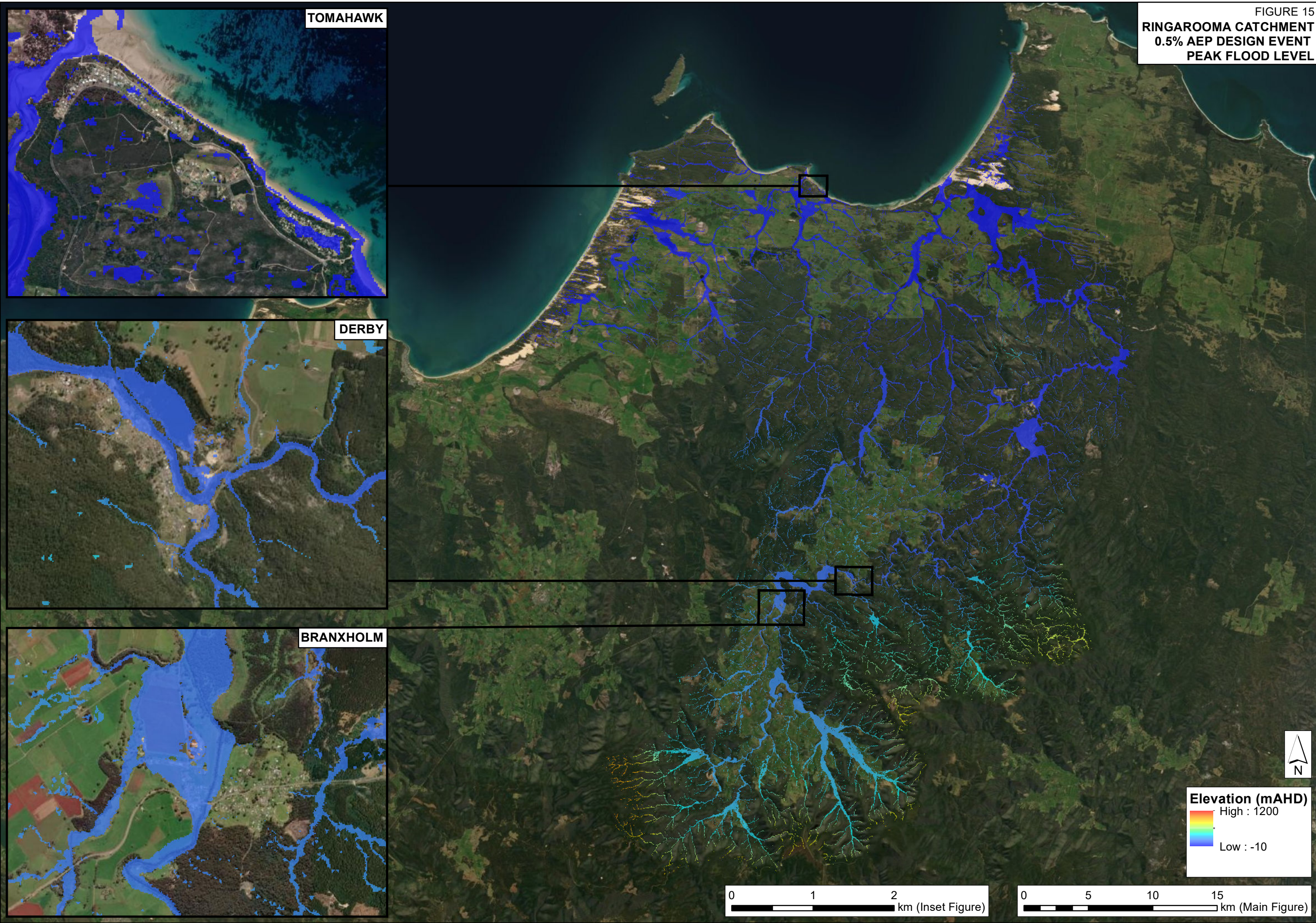
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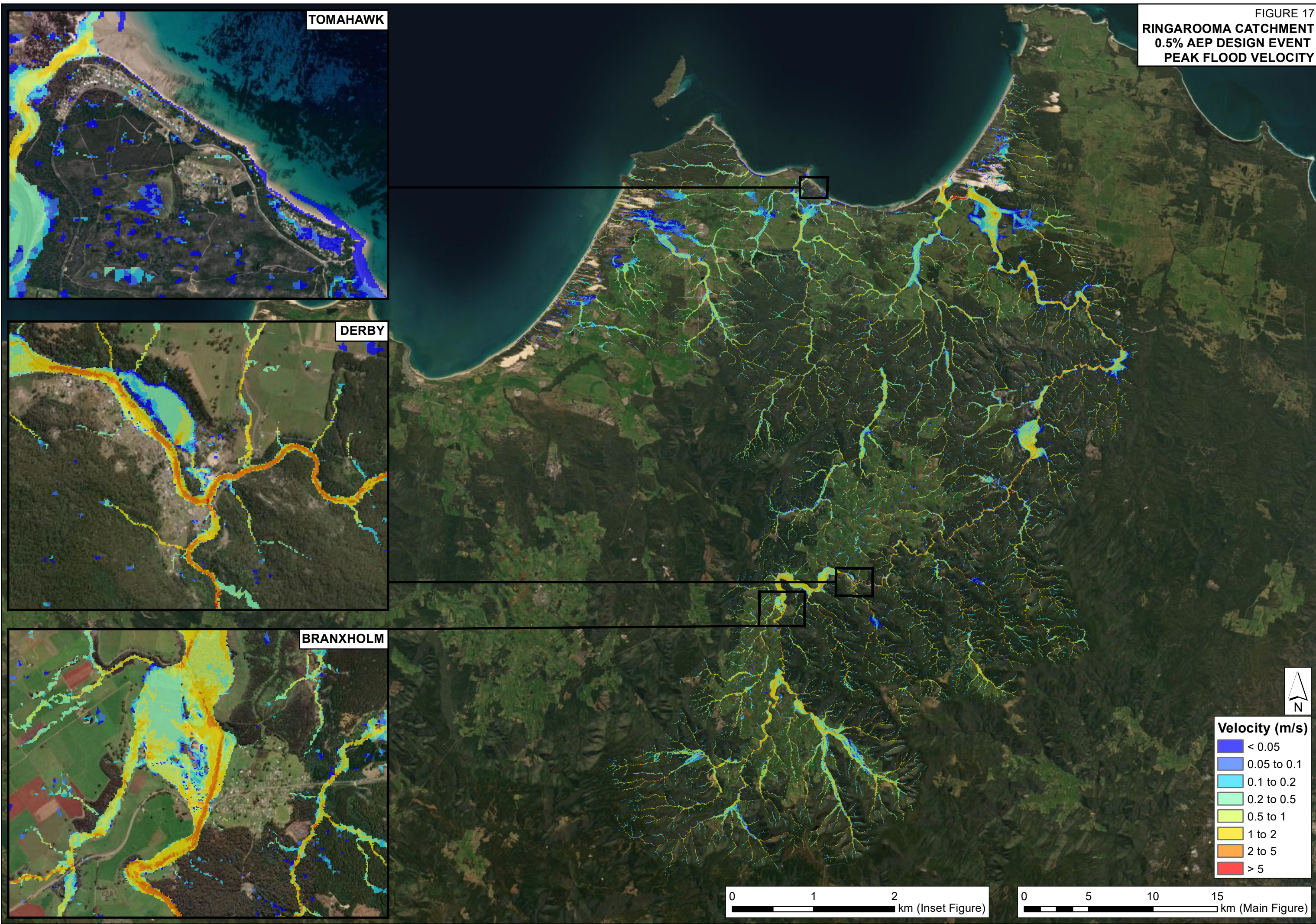


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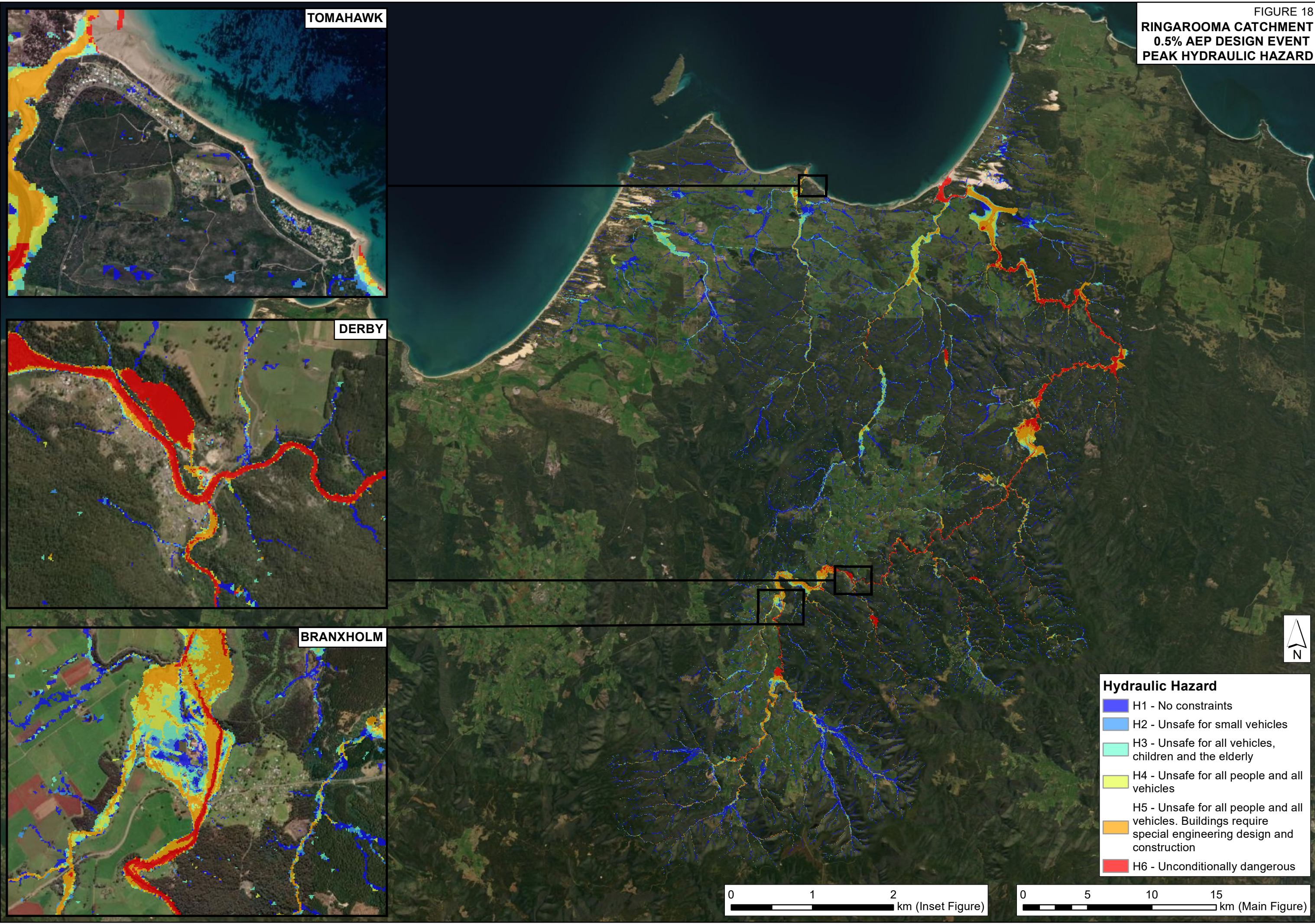


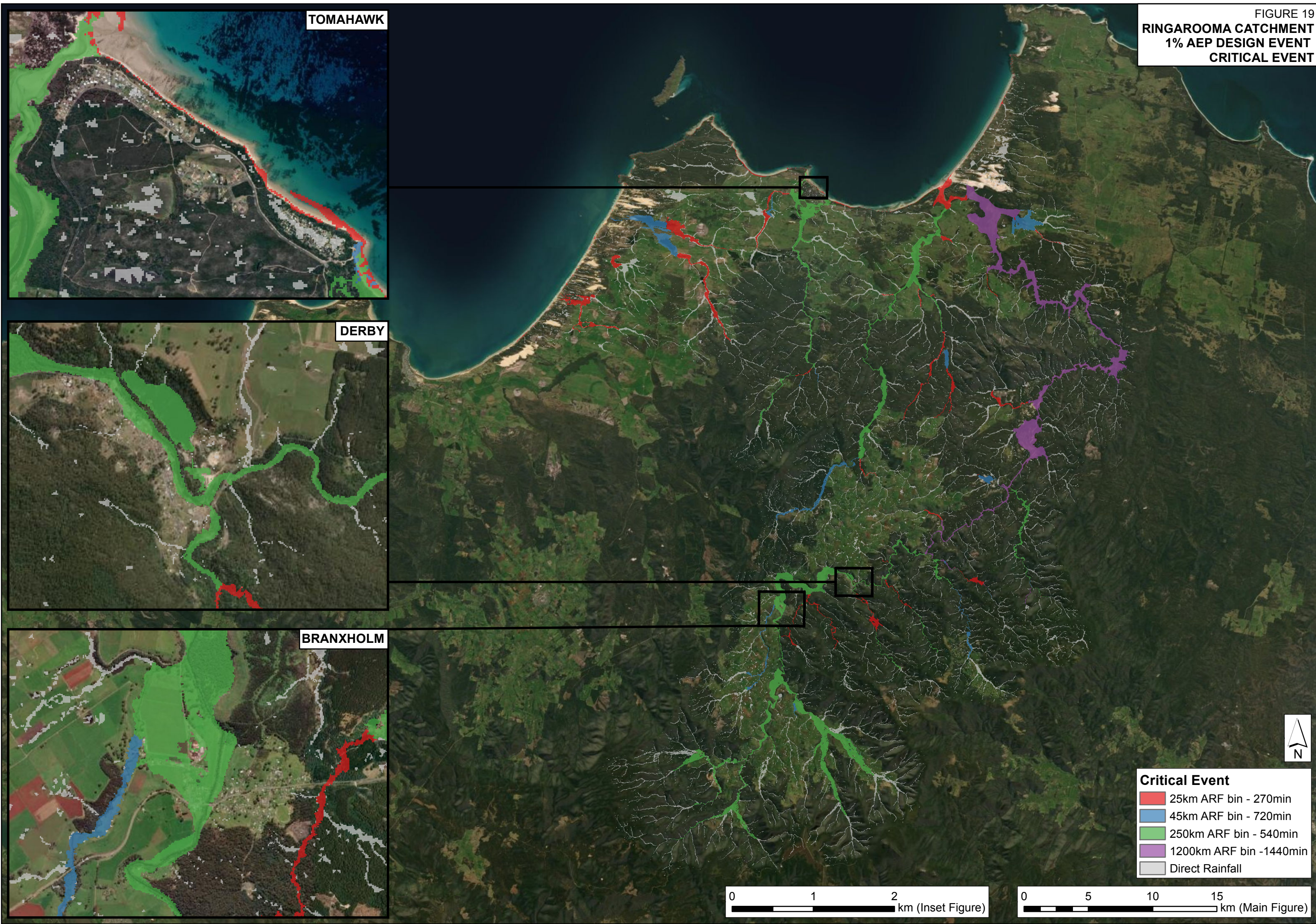
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APPENDIX A. DESIGN EVENT DATA

FIGURE A1
DESIGN RAINFALL DEPTHS
540MIN 2%AEP

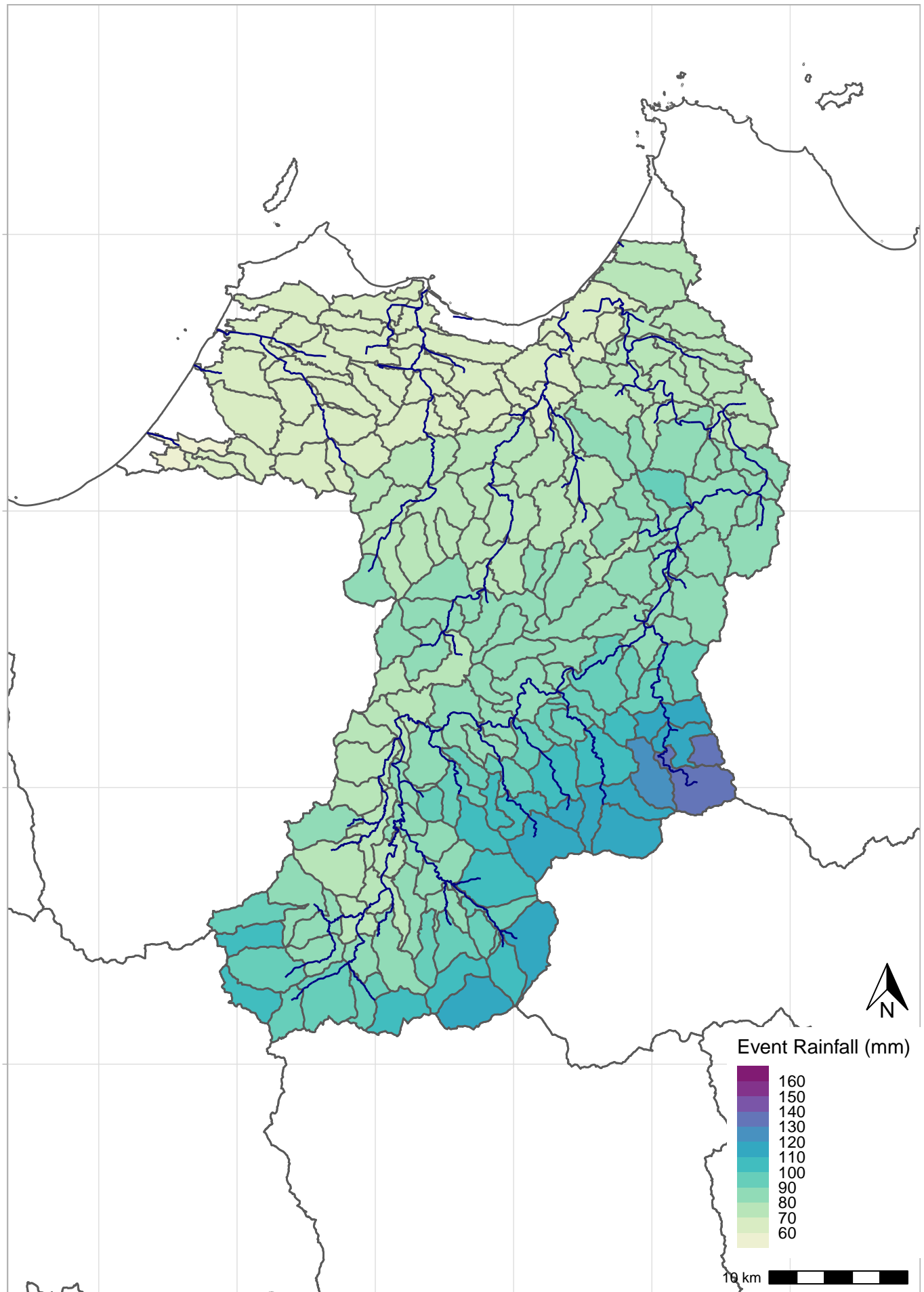


FIGURE A2
DESIGN RAINFALL DEPTHS
540MIN 1%AEP

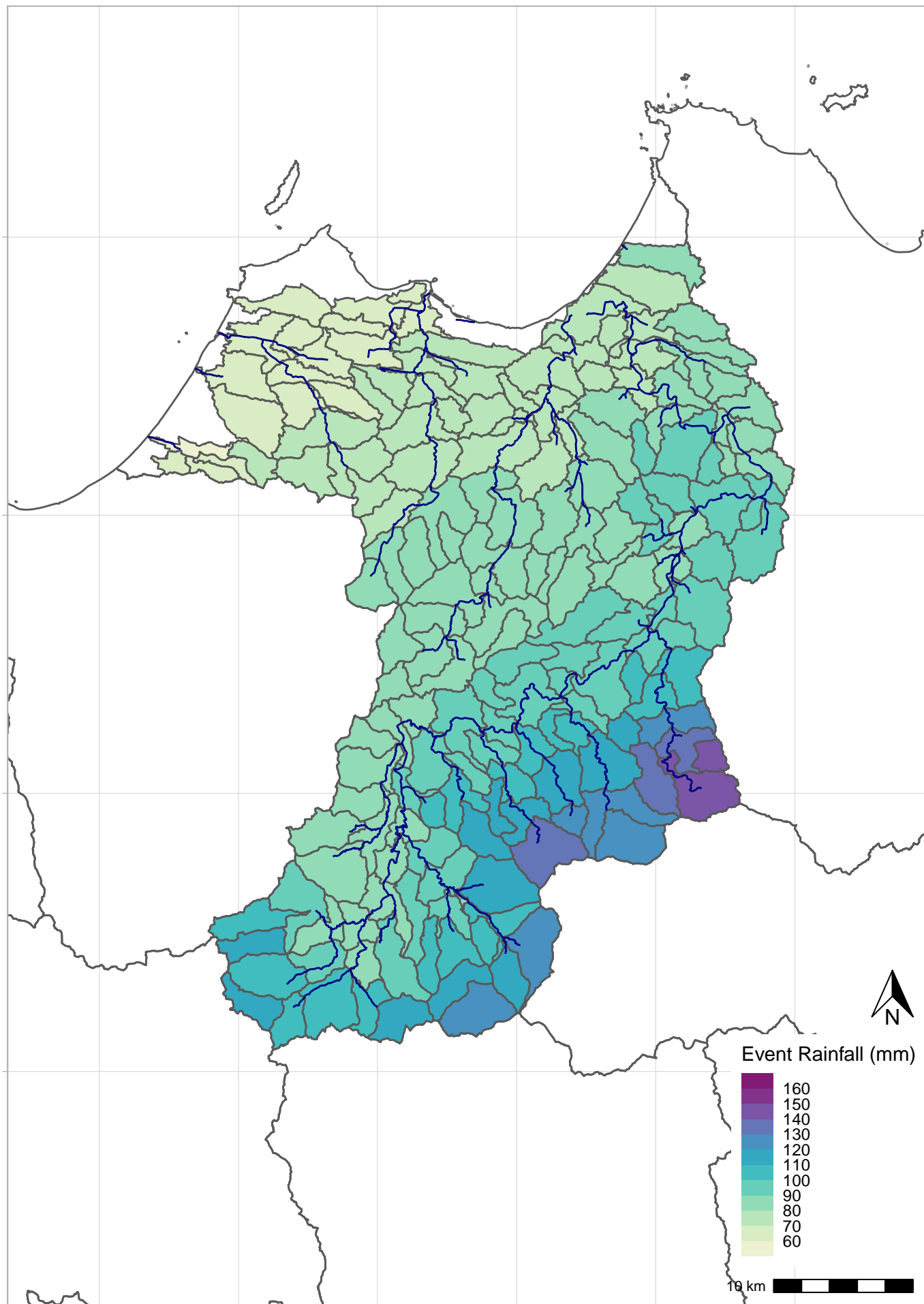


FIGURE A3
DESIGN RAINFALL DEPTHS
540MIN 1IN200AEP

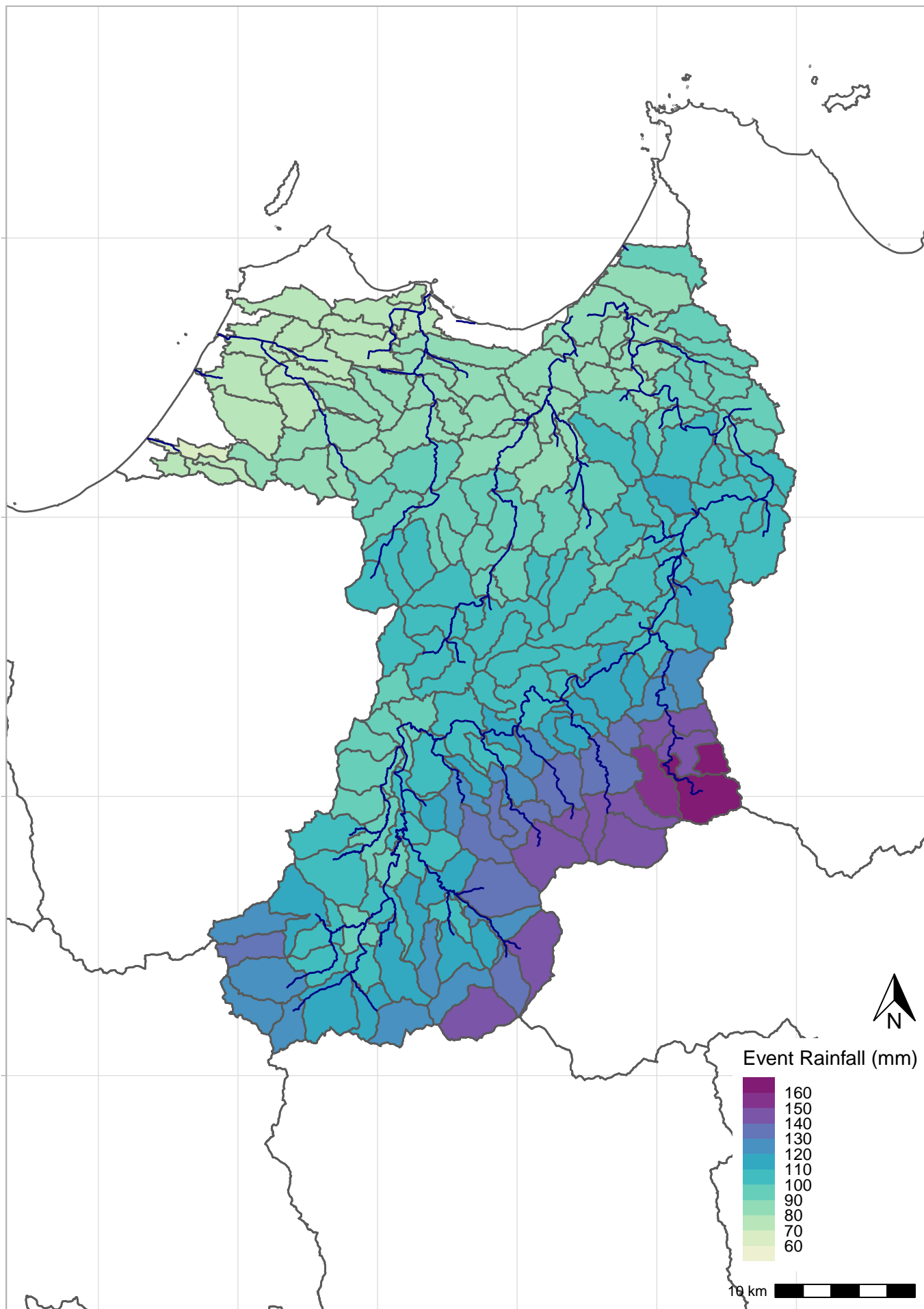
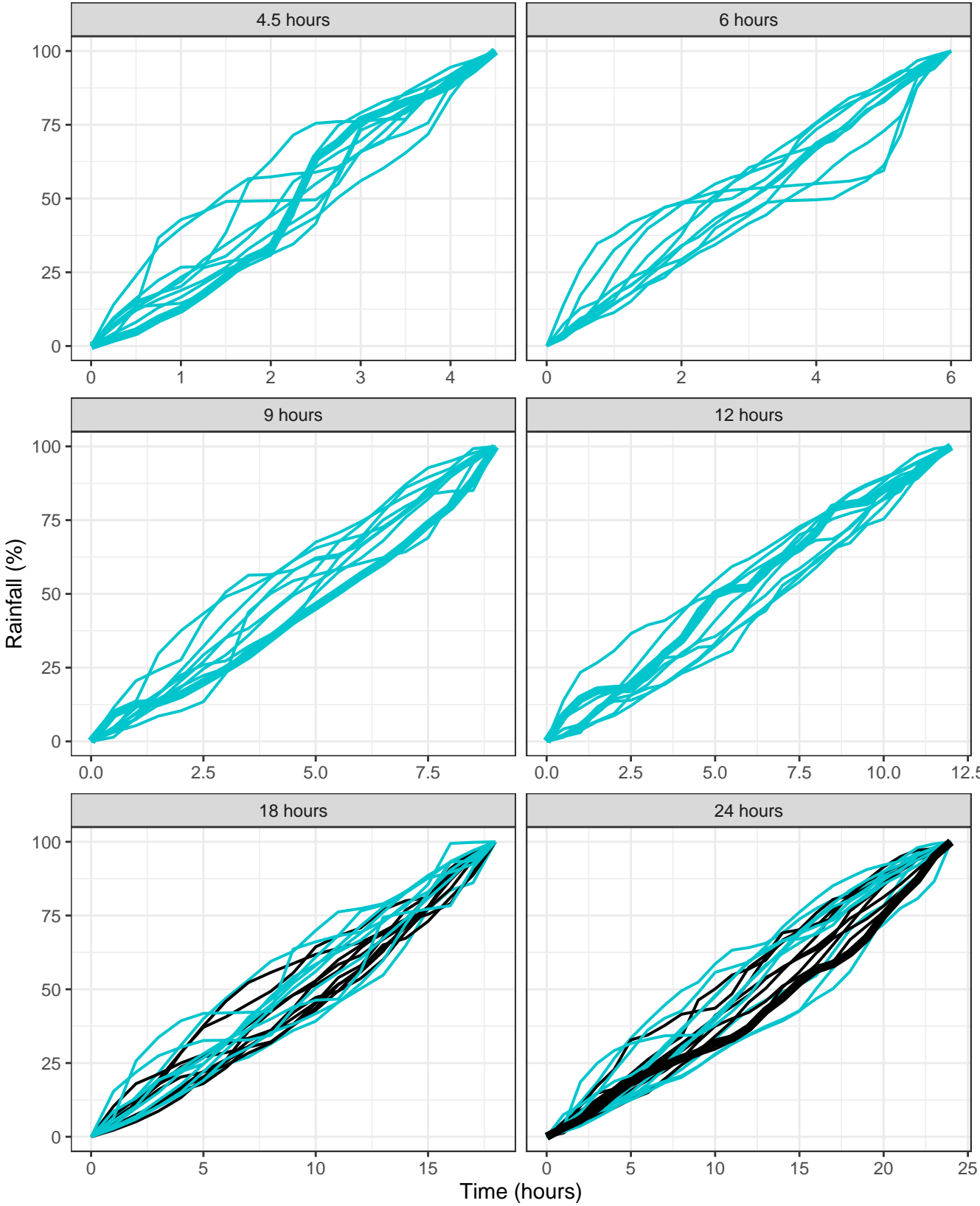


FIGURE A4
DESIGN AREAL TEMPORAL PATTERNS
DURATIONS FROM 4.5 TO 24 HOURS



TP Type Selected.ATP Selected.PTP Design TP.s.ATP Design TP.s.PTP



APPENDIX B. DESIGN PEAK ERRORS

Figure B1
Ringarooma Catchment
Percentage error in peak flows using selected runs
2% AEP

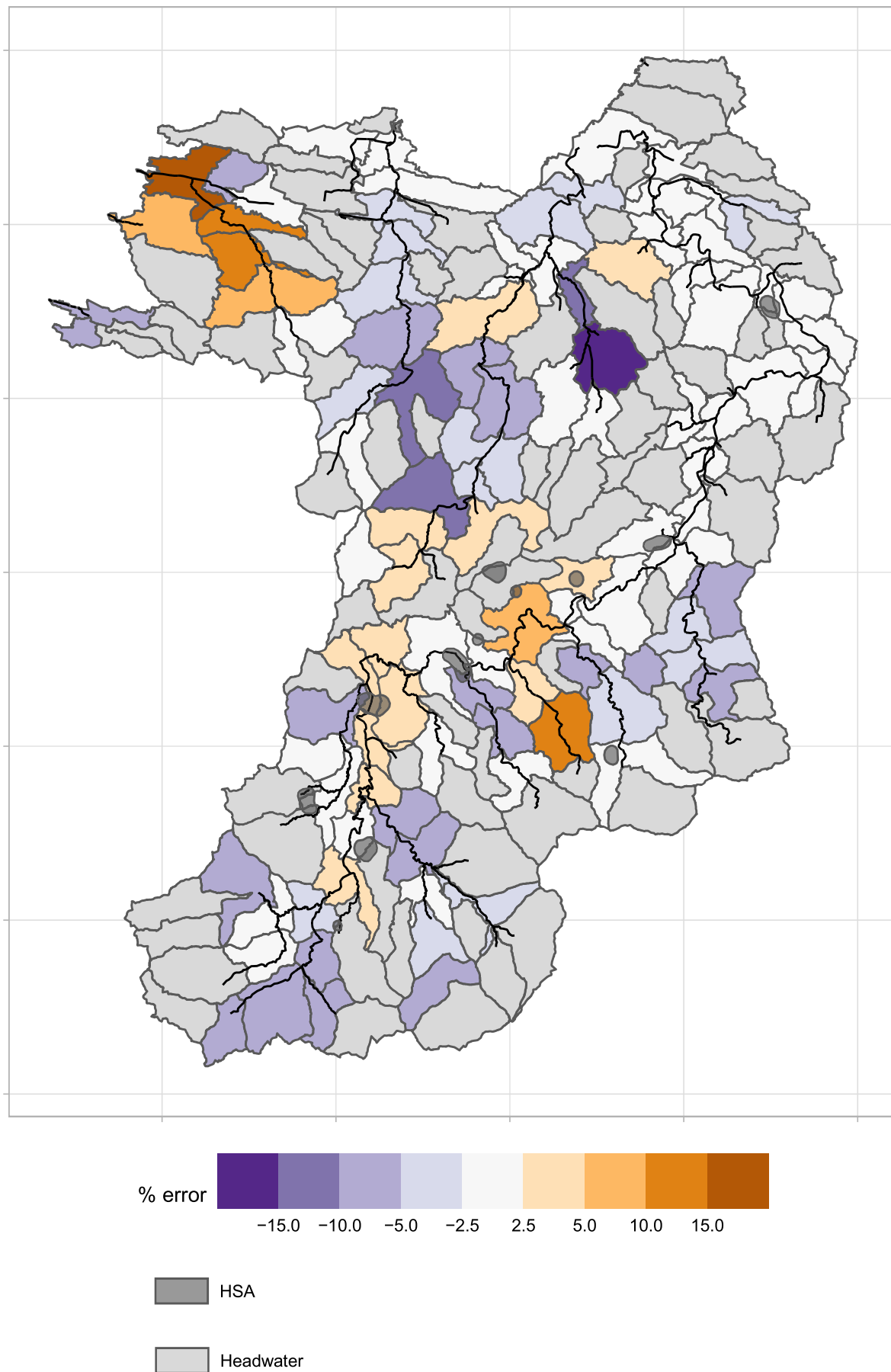


Figure B2
Ringarooma Catchment
Percentage error in peak flows using selected runs
1% AEP

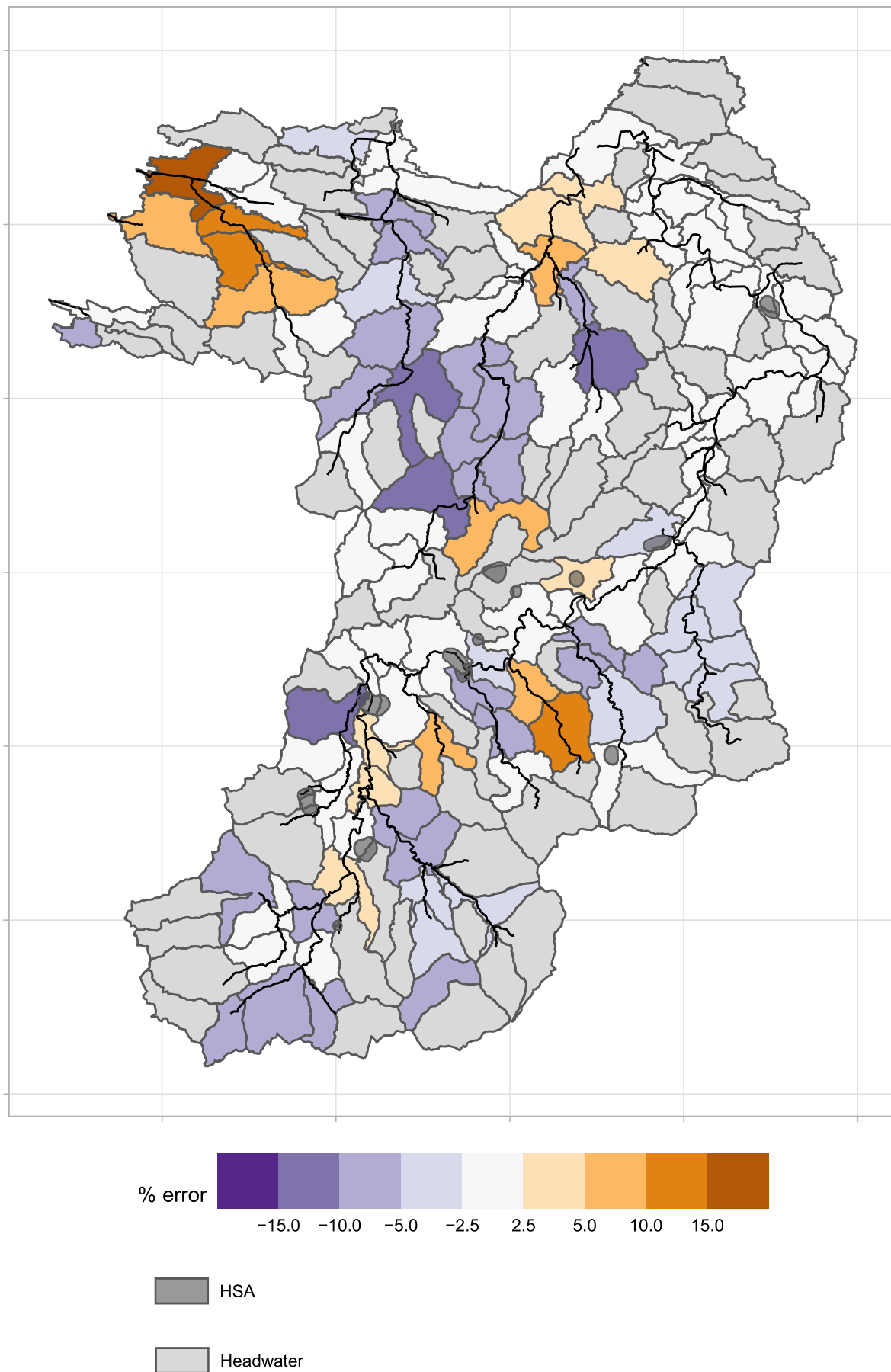


Figure B3
Ringarooma Catchment
Percentage error in peak flows using selected runs
1in200AEP

