A heatwave classification for heat related fatality risk

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BNHCRC scenario project

• Develop a set of realistic disaster scenarios:
  o TC, EQ, ECL, HW in QLD, VIC/SA and NSW
  o Quantify hazard magnitude and risk thresholds
  o Assess vulnerability and exposure at risk

• Use this framework to help:
  o Better understand / **communicate** about extreme disaster risk
  o **Assess capability** from emergency management sector
Heatwaves

- HW are responsible for **more deaths than all other natural perils in Australia put together** (Risk Frontiers, 2014)

- Lack of a **clear definition** of a HW event
  - pressing need for a common intensity metric

- BoM developed the **Excess Heat Factor** with this goal in mind

- Our aim is to create a **category system for risk to human life**
Hazard risk categories

- What we can learn from other perils (TC/BF):
  - Need for a **simple and clear** cat system
  - Extension beyond initial scope is dangerous

- What we aim to achieve here:
  - Define a category system specifically for **risk to human life**
  - Quantify that risk for each category: **guidelines** as to what can be expected
Starting point: Excess Heat Factor

• The EHF metric takes into account:
  – the ability of the local community to adapt to its climate
  – the impact of sharp temperature spikes that do not allow such acclimatization

• A positive EHF indicates a heatwave

• A HW event magnitude can be measured by
  • the peak EHF
  • the accumulated EHF (Heat Load)
Spatial definition: event “footprint”

- An event starts when first grid cell in domain has EHF > 0
- Finishes when last cell turns back to EHF=0

JAN 1959
EHF & fatalities: input data

- BoM: 100 year record of gridded daily temperatures (max, min).
- Risk Frontiers’ fatality database (Peril Aus): date & location of fatalities + cause of death.
Fatality risk categories

- For each fatality record (224), compute EHF estimates ($EHF_{\text{sum}}$, $EHF_{\text{max}}$)
  - 12 days period

<table>
<thead>
<tr>
<th>Category</th>
<th>$EHF_{\text{sum}}$</th>
<th>$EHF_{\text{max}}$</th>
<th>Mean number of fatalities</th>
<th>Percentage of record covered</th>
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</thead>
<tbody>
<tr>
<td>CAT0</td>
<td>&gt; 0</td>
<td>&gt; 0</td>
<td>5</td>
<td>82.6</td>
</tr>
<tr>
<td>CAT1</td>
<td>&gt; 30</td>
<td>&gt; 15</td>
<td>6.7</td>
<td>55.4</td>
</tr>
<tr>
<td>CAT2</td>
<td>&gt; 80</td>
<td>&gt; 30</td>
<td>8.6</td>
<td>38.9</td>
</tr>
<tr>
<td>CAT3</td>
<td>&gt; 150</td>
<td>&gt; 50</td>
<td>10.4</td>
<td>28.6</td>
</tr>
<tr>
<td>CAT4</td>
<td>&gt; 300</td>
<td>&gt; 70</td>
<td>18.5</td>
<td>12</td>
</tr>
</tbody>
</table>
Example: JAN 1959

Peak EHF over the event (1959)  
EHF accumulation over the event  
Fatality risk categories (1959)
Quantifying the risk

Fatality rate curve

- 10 biggest events of the last decade in Vic/SA
- Census population records trended over the period
- Normalised heat-related fatality records
• Risk of under-reporting / wrongly-categorising deaths

• Few events to map the range of risk: fatality rate is a distribution at each point

• Range of curves by age, etc... need for more data!

• Communities & governments learn from past experience and improve their level of preparedness
• EHF based category system

• Specifically designed to characterize heat related fatality risk

• Fatality estimates for each category

• These estimates are very uncertain... and more records are needed
Scenario building

- Generate hazard footprint ($EH_{sum}$, $EH_{max}$) consistent with historical obs... but potentially more extreme
  - Principal component analysis

- Compute associated categories
- Make assumptions on population density
- Apply fatality curve to compute death rate
- Sample a number of fatality for each cell
Historical event footprints
Scenario 1

- Coastal event impacting both Adelaide and Melbourne with Cat 4 HW
- 86 fatalities
Scenario 2

- Inland event
- Higher intensity overall hazard but impacting less populated regions
- Adelaide in cat 4 and Melbourne in cat 3 risk
- 35 fatalities
Scenario 3

- Most severe of the 3 scenarios in terms of hazard intensity
- Peak Cat 4 risk in Adelaide
- Melbourne in Cat 3 risk
- 41 fatalities
Extreme scenario

<table>
<thead>
<tr>
<th>Category</th>
<th>$\text{EHF}_{\text{sum}}$</th>
<th>$\text{EHF}_{\text{max}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT4</td>
<td>$&gt; 300$</td>
<td>$&gt; 70$</td>
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<tr>
<td>CAT5</td>
<td>$&gt; 450$</td>
<td>$&gt; 100$</td>
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