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Implications of climate change for Australia's security.

This submission is from the Australian Research Council's Centres of Excellence for Climate System Science[1] and Climate Extremes. We are Australia's leading University research consortia comprising the University of New South Wales, The Australian National University, The University of Melbourne, Monash University and the University of Tasmania. We include multiple lead authors and review editors of the Intergovernmental Panel on Climate Change, members of the Australian Academy of Science, Fellows of the Australian Meteorological and Oceanographic Society, the American Meteorological Society and the American Geophysical Union.

a. the threats and long-term risks posed by climate change to national security and international security, including those canvassed in the National security implications of climate-related risks and a changing climate report by the United States Department of Defense;

We note that threats associated with climate change to national security are not only a long-term threat. The risks of dangerous heat events have already increased and can be attributed to human emissions of greenhouse gases[2]. Heatwaves have increased in many parts of the world[3] including Australia[4]. Future changes in heatwaves are inevitable, with very likely increases in the frequency, magnitude and duration of events. Heatwaves increases are linked with the average global warming such that reducing warming minimizes increases in heat extremes[5].

We therefore agree with the assessment by the US Department of Defense (US Senate Report 113-211) that:

> *Global climate change will have wide-ranging implications for U.S. national security interests over the foreseeable future because it will aggravate existing problems—such as poverty, social tensions, environmental degradation,*

[1] Details can be obtained from www.climatescience.org.au or on request.
[2] King, A.D. et al., 2016, Emergence of heat extremes attributable to anthropogenic influences, Geophys. Res. Lett., 43, 3438–3443, doi:10.1002/2015GL067448.
[3] Perkins, S.E. et al., 2012, Increasing frequency, intensity and duration of observed global heatwaves and warm spells, Geophys. Res. Lett., 39, L20714, doi:10.1029/2012GL053361.
[4] Perkins, S.E., L.V. Alexander, 2013, On the Measurement of Heat Waves, J. Climate, 26, 4500-17, 10.1175/JCLI-D-12-00383.1
[5] King, A.D. et al., 2017, Australian climate extremes at 1.5°C and 2°C, Nature Climate Change, 7, 412-418, doi: 10.1038/NCLIMATE3296

> *ineffectual leadership, and weak political institutions—that threaten domestic stability in a number of countries.*

and we note that this assessment is valid for Australia. However, the "wide ranging implications" noted by the US Department of Defense are very general. Discovering where poverty will increase, or when social tensions might rise both within Australia and within our sphere of influence is extraordinarily challenging and our judgment is that predicting these sorts of changes definitively is beyond current capability.

Beyond temperature extremes, there is also strong evidence of intensifying rainfall in certain regions[6]. There is less evidence of strong signals relating climate change with storm frequency, and on average storms are not obviously intensifying. However, this is not to be misunderstood – severe storms are rare and therefore the observations and associated statistics required to demonstrate a trend (or lack thereof) are not yet available. If a specific event is examined, links between warmer sea surface temperatures and higher amounts of rainfall can commonly be demonstrated[7] and it is likely that with on-going warming of ocean temperatures individual storms will become more intense and may change in their geographical reach.

Most assessments linking climate change with climate risk have assumed changes are well described by the average. We recommend that the thinking on this is urgently modified to focus on (a) extreme events and (b) compound events. Most scenario development to stress test systems examine how warming of 2^{o}C or 4^{o}C would impact. These broadly assume the weather and climate would simply change by a linear amount reflecting the warming and that the spatial and temporal character of events would only slightly change.

The evidence is rather different. As the Earth warms, the relationships between the large-scale climate and local weather changes because the connections that link the large- and local-scales change. Our knowledge of these connections is weak; they occur at scales not resolved by climate models, which limits the applicability of information sourced from these tools. In short, and perhaps with the exclusion of temperature, our knowledge of the detail of how extremes (including weather events) will change in the future at scales relevant to national security is very limited. We do not know where or when extreme events will hit, which regions will become less vulnerable and which regions will suddenly emerge to be vulnerable. This lack of knowledge is tractable but the scale of research activity in Australia relevant to these areas is limited.

Compound events[8] have recently emerged within climate science as an issue of concern and priority[9]. In isolation, a heatwave, or a major storm commonly does not affect systems catastrophically since we engineer resilience into our systems. Traditional assessments of climate extremes and their impacts are usually not tailored

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[6] Tan et al, 2015a, Nature, 10.1038/nature14339

[7] Evans, J. P. and I. Boyer-Souchet, 2012, Local sea surface temperatures add to extreme precipitation in northeast Australia during La Niña, *Geophys. Res. Lett.,* **39**, L10803, doi:10.1029/2012GL052014.

[8] **Compound (weather/climate) events** refer to an event where multiple drivers have combined to affect a hazard that affects a socioeconomic or environmental system.

[9] Leonard, M. et al., 2014, A compound event framework for understanding extreme impacts, Wiley Interdisciplinary Reviews: Climate Change, 5, 113-128, 2014.

to incorporate the effects of multiple climatic drivers – and so an examination of risks due to sea level rise tend to be examined independently of risks associated with storm surge and river flooding. The probability of one of these – a high tide, a storm surge or a river flood are reasonably understood. The probability of the simultaneous co-occurrence, or the rapid re-occurrence of phenomena is rarely examined. One exception is evidence of substantial increases in the simultaneous occurrence of droughts and heatwaves in the United States[10].

There is little work within Australia of the risk of compound events, despite these providing the mechanisms to cause catastrophic failure of a system. Some examples are emerging, including the better understanding of how phenomenon might be deterministically connected (e.g. cyclone risk over Northern Australia with heatwave risk over Victoria[11]). There are also clear links between how dry a landscape is, warming, evaporative demand and heatwaves[12], between antecedent soil moisture and bush fire risk[13] and between soil moisture and daily extreme temperatures[14]. However, how compound event risks that might challenge Australia's security will change in the future, is effectively a blank canvas.

b. the role of both humanitarian and military response in addressing climate change, and the means by which these responses are implemented;

No response

c. the capacity and preparedness of Australia's relevant national security agencies to respond to climate change risks in our region;

This is not simple to judge because the risks associated with climate change, at least in terms of the events that might exceed the capacity of Australia's relevant national security agencies to respond is largely unknown. The discussion of compound events under (a) is particularly relevant here.

Assessment of the climate change risks associated with those phenomenon that might exceed the capacity of Australia's relevant national security agencies to respond needs work. Unfortunately, the tools required to enable a quantification of this assessment are not yet developed. Scenario development and stress testing of capability, with proper consideration of compound events is probably a first order priority. This can be done within the normal war-gaming frameworks used, but expert judgment would be needed to design appropriate scenarios.

For example, a failure of the Asian monsoon, full-scale agricultural failure and famine

[10] Mazdiyasni, O. and A. AghaKouchak, 2015, Substantial increase in concurrent droughts and heatwaves in the United States, *Proc. National Academy Sci*., doi: 10.1073/pnas.1422945112.
[11] Parker, T. J. et al., 2013, The influence of tropical cyclones on heat waves in Southeastern Australia, Geophys. Res. Lett., 40, 6264–6270, doi:10.1002/2013GL058257.
[12] Cai W. et al., 2009, Rising temperature depletes soil moisture and exacerbates severe drought conditions across southeast Australia, *Geophys. Res. Lett.*, 36, doi:10.1029/2009GL040334.
[13] Kala, J. et al., 2015, Influence of antecedent soil moisture conditions on meteorological conditions during the Black-Saturday bushfires in Australia, *Q. J. R. Meteorol. Soc*., 141, 3118-29, doi: 10.1002/qj.2596.
[14] Donat, M.G. et al., 2017, Regional warming of hot extremes accelerated by surface energy fluxes, Geophysical Research Letters, 44, 7011–7019, doi:10.1002/2017GL073733.

in China is arguably more likely than a direct military invasion of Australia. The latter is integrated into national preparedness planning, the former is not but would have dramatic impacts on Australia. These kinds of low probability, high impact events are not systematically assessed within the research community. There are several – ice sheet failure in Antarctica, slow-down in the thermohaline circulation, large scale ecosystem collapse[15,16,17].

d. the role of Australia's overseas development assistance in climate change mitigation and adaptation more broadly;

Risk associated with climate change cannot be avoided but it can be mitigated. Prioritizing building resilience to weather extremes is one step that directly reduces vulnerability. This has the direct benefit that if a region does not turn out to be vulnerable to future climate, current climate risks would still be moderated.

One major opportunity for Australia is to lead the innovation required to assess climate related risk across our region. Australia could lead the development of the methods required to improve our ability to project changes in extremes and any emergence in new risks associated with compound events. This would require a coordinated national effort linked with existing international partners, would require at least a decade of sustained investment and strong input from vulnerable communities. It cannot be achieved with a 2-3 year project. It will also require infrastructure investment, as foreshadowed in the 2016 National Research Infrastructure Review[18], to support high performance computing, high performance data systems and a nationally integrated approach to climate system modelling.

e. the role of climate mitigation policies in reducing national security risks; and

No response

f. any other related matters.

We make the following recommendations:

- Australia lags behind the US and some European countries in examining, assessing and responding to climate change risks in terms of national security. Vulnerabilities associated with national security and climate change are already increasing and exist now. These are not "future issues" that can be left for a decade before strategies are considered. The creation of a high-level taskforce to examine risks associated with climate change and national security is urgent and overdue.

- Australia lacks the tools to quantify risks associated with future climate extremes, and in particular compound events. Resolving this will require sustained

[15] Alley, R.B. et al., 2003, Abrupt climate change, Science, 299, 200-210.
[16] Lenton, T.M., 2011, Early warning of climate tipping points, Nature Climate Change 1, 201–209, doi:10.1038/nclimate1143.
[17] Lenton, T.M. et al., 2008, Tipping elements in the Earth's climate system, Proceedings of the National Academy of Sciences, 105, 1786-1793, doi: 10.1073/pnas.0705414105.
[18] https://www.education.gov.au/national-collaborative-research-infrastructure-strategy-ncris

investment in model development. Australia has been walking away from model development; we now import that capability from the UK and US. Examination of whether those imported tools are fit for purpose for our national assessment of risk should be undertaken. This assessment is not a climate science problem; it is very much an assessment of risks to national security from multiple factors, and then an evaluation of the quality of information available from the climate science community.

- Assessing and managing climate change in terms of national security cannot wait for properly assessed quantification of risk. While developing tools to quantify risk is important, in the meantime scenario development incorporating climate extremes is urgent. Australia needs to have plans ready for low probability events. Scenario development requires expert judgment therefore, and would be a role for the high-level taskforce noted above.

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