Supplementary Submission No 148t

INQUIRY INTO INQUIRY INTO MUSEUMS AND GALLERIES

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Analysis of 'Flood Study' report for new Powerhouse Museum Riverbank site in Parramatta dating from November, 2016. (07 08 2018)

The 'Flood Study' report was submitted as part of the 'Extended Final Business Case' to Cabinet by Johnstaff consultants,Minister for the Arts/various Agencies, April 2018. Document authored by Taylor Thomson Whitling Pty Ltd, engineers [TTW].

Analysis: by Dr. Lindsay Sharp

1.0 SUMMARY:

Museums are built to last centuries.

Museum buildings contain irreplaceable collections and vulnerable visitors and staff.

They represent massive social and economic investement in cultural capital which engages us, tells our stories and helps us make meaning from within our individual lives and together, within our communities.

Responsible planning ensures these assets are protected from existential risks which are forseeable.

The proposed Riverbank new museum site at Parramatta is already forseeable as an avoidable flooding risk by 2120 which may host a worst case flood whose maximum surge height is approximately 14-17 metres above current normal river level. This is due to possible exponential sea rise caused by global warming; and conjunction with king tides; maximum precipitation in a worsening catchment area enhancing rapid flood concentration and force; and East Coast Lows becoming more destructive, powerful and hydrologically superabundant.

It is no coincidence that the present Government of NSW has proved to be reluctant to publish maps and data showing the potential range of effects on water/sea/littoral adjacent properties around the State and especially in Sydney. Present popularly available maps fail to show any of this downside risk: http://www.coastalrisk.com.au/viewer

The risks are currently being further analysed on a global scale. In 2012 Hansen et. al supplied detailed analysis indicating such risks may be greater based on exponential feed-back loops and cumulative glacial base lubricant effects in Antarctica and Greenland. Their most recent paper appeared in July 2018 in a Royal Society publication. It is highly controversial but the mechanisms they identify and the empirical, historical data they quote indicate sea rise, and conflative flood risk maxima thereof, may have been wildly and widely underestimated.

In planning museums the old medical first principle also applies: 'First do no harm'. Which is precisely the opposite of this cavlier and foolish proposal underpinned as it is by this flood risk report which appears to have been developed by witless engineering dullards.

If any one questions such an extreme event could not happen within the next century at Parramatta we only have to mention the recent Brisbane flood and the art gallery's inundation thereby.

2.0 The Report: acknowledged fudging early on:

On page 8 this report acknowledges that :

' Both reports include UPRCT flood model levels…with the same allowance made for the impact of climate change… [an] increase of 15% in design rainfall intensities, with no allowance made for sea level rise…' (see below). The 15% Climate Change impact figure appears plucked from the sky. Later comments in the report suggest that actually a 30% allowance for detailed design rainfall intensities should be allowed. See 'weasel words' at the end note.This will change all calculations and modelling.Notwithstanding, when local flood levels are added to regional flood levels based on these earlier reports/studies this document notes an added maximum increase in flooding at the site of 6.98 metres [ARI + CC]. '

More recent analysis of sea level rise (2018) linked to maximum tides have suggested that another 0.74 metres may be added overall to the basal water level (see notes below) so as to encompass currently calculated maximum risk. This addition ***does not*** take into account Hansen et. al's analysis but relies on the now admittedly underestimated IPCC's tables.

3.0 Complex circumstances:

The complexity of this Paramatta locale, added to the change in topography caused by new structures/surfaces both there and higher up the river, makes it very difficult to predict what the maximum flood risk will be around, across and into this site over the next eight decades. Hansen et al's papers to the Royal Society however add an entirely different level of risk which prudential planning would suggest be taken as avoidable existential maxima. This risk statement, based on exponential as opposed to linear melt models in Greenland and especially Antarctica, postulates an additional 5 metres maximum in sea level rise. This has to be taken into account when planning museum buildings out over a 100 year span.

With the expansion of hard surfaces in catchment areas for the Parramatta River and thus increasing levels of and rates of water flow into the river; with the possibly exponential increase in actual rainfall on certain (increasingly less rare) occasions; with the unpredictability of tidal, storm and sea level rises out over 100 years; and with the rate of global warming around Antartica and Greenland (which is already demonstrating much faster melting of the latter's ice sheet and of the western Antarctic ice sheet) to claim that the provision of built space for the new Museum above the predicted flood levels, on the data quoted here, remains safe is, in fact, remarkably risky and profoundly imprudent.

Despite the Government's unjustified destruction of the Powerhouse Museum's Ultimo buildings after only 30 years it is recognised by our profession that museum buildings should be designed to last many decades even a few hundreds of years. Unable to accurately predict maximal flooding in a reliable way even out over half a century, for Government to construct a museum on the Riverbank site is obvious folly.

It is also clear that Government have not interrogated this Johnstaff/TTW report openly and thoroughly or updated it with new data as these become available.

4.0 Engineering folly:

Equally, the engineering of the new site begs many questions. For example even at the suggested first floor (as opposed to basement and sub-basement levels facing the river) level of 7.5 metres ARI the addition of higher tidal levels require more clearance from these predicted maximal flood levels. With that said this first floor level has to be suspended to a certain degree and must also be engineered to safely hold up some very large objects which weigh up to fifty tons. This will require heroic engineering on top of (literally and figuratively) the additional flood mitigation engineering.

5.0 Heavy and large objects: access and equipment

To this expensive engineering complexity must be added access for very large and heavy objects coming off Philip Street at a ninety degree angle, up a relatively steep slope caused by a three metre (minimum) rise over forty or so metres. Even then the 8 metre high approx. ground level is by no means guaranteed to be above maximum flood risk during an epochal level flood exacerbated by a maximal tidal event and sea rise.

The transport and access issues for the huge objects alone raise profound issues of risk and cost quite apart from that. Then there is the risk to HVAC, elevator and electrical equipment which is usually located in basement areas with some additional machinery distributed above throughout the building. This site obviates against location of these facilities lower down since they face unavoidable flood risks. Heavy, inherently dangerous and complex in a museum, the cost of locating this equipment above any flood risk is expensive and challenging.

As for cars parked at lower levels, or stores or other equipment- it is good bye, Charlie.

There are other concerns such as the impact of rapidly flowing flood waters and the massive piling required due to the site substrates, but those noted above alone should end this zombie of a project.

6. 0 NOTES:

Refer below to Dr. John Macintosh's '20 year Flood Map Parramatta', taken from Macintosh's submission [174] to the Inquiry, January 2018. The Macintosh report has never been deconstructed or rejected by Government. This is obviously a matter of suspicion. The Maps produced by Dr. Macintosh versus by TTW suggest significant variations which are deeply concerning.

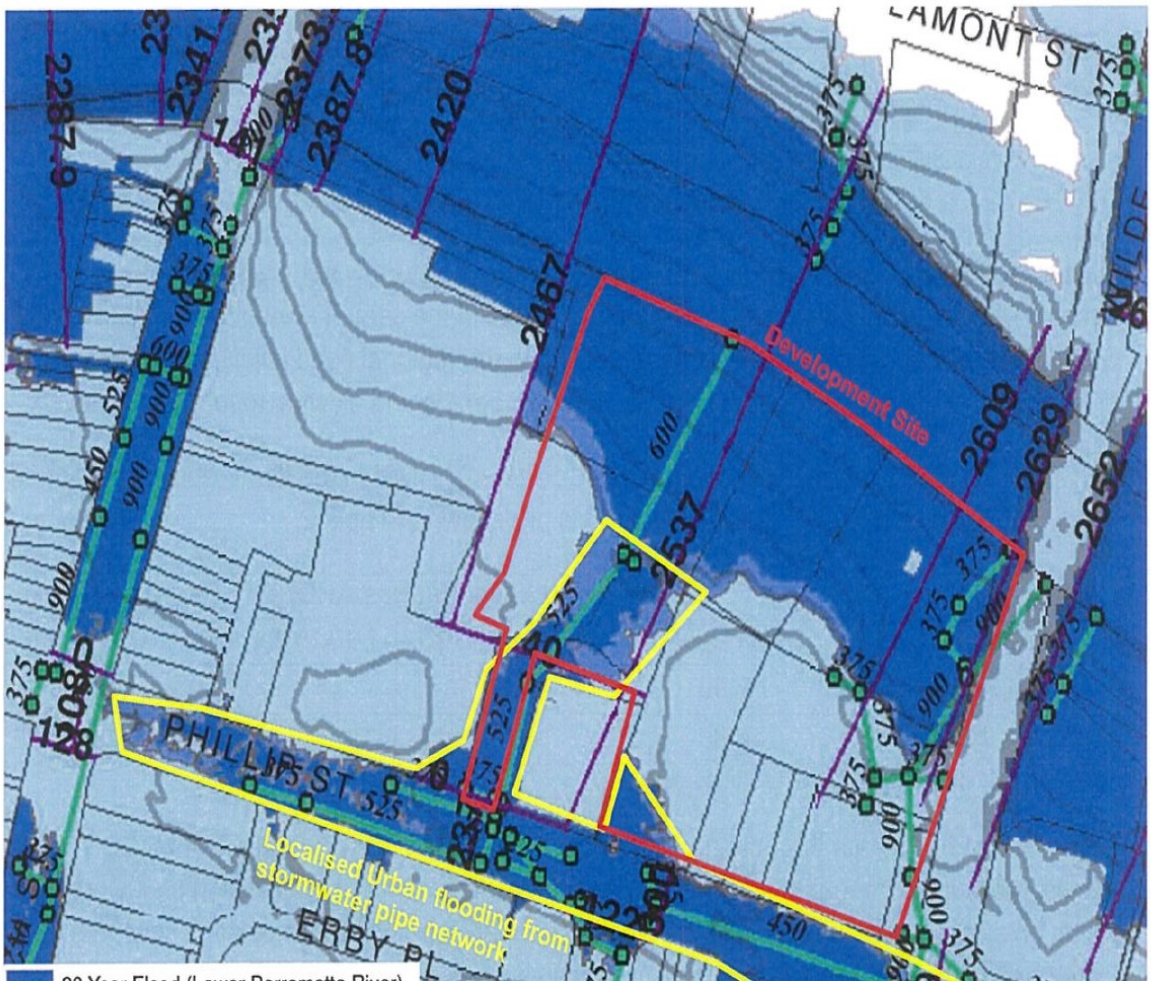
A 100 year flooding/maximum tidal event has not apparently been modelled insofar as that is reliably achievable at present. The rate of impact of climate change/warming on the two key ice sheets and the already embodied CO2 in the atmosphere with its lagged warming effects are altering every six months (worst case) in a negative fashion. On that basis the map of existing flooding which follows, on a 100 year timescale, is both unhelpful and probably misleading.

Johnstaff/TTW map of existing flooding:

3.1 Existing Flooding

The development site is within the Upper Parramatta River Catchment and at this location, the river is not tidal. The Lower Parramatta River Catchment, and tidal influence, begins east of Charles Street Bridge and weir.

The City of Parramatta Council flood map (included in Appendix C) shows that the development site is affected by regional flooding from the Parramatta River. The site is located within the extents of the PMF and partially located within the extents of the 100 and 20 year ARI flood (refer to Figure 4).



The Flood Hydraulic Hazard map which follows is perhaps even more sub-optimal:

The CPC flood hydraulic hazard map shows that the development site is within the high and low hydraulic hazard. Within the site, the boundary between high and low hydraulic hazard correlates with the 5m ground contour (refer to Figure 5). Table 3 summarises the different flood risk precincts within the site and the associated ground level of the site.

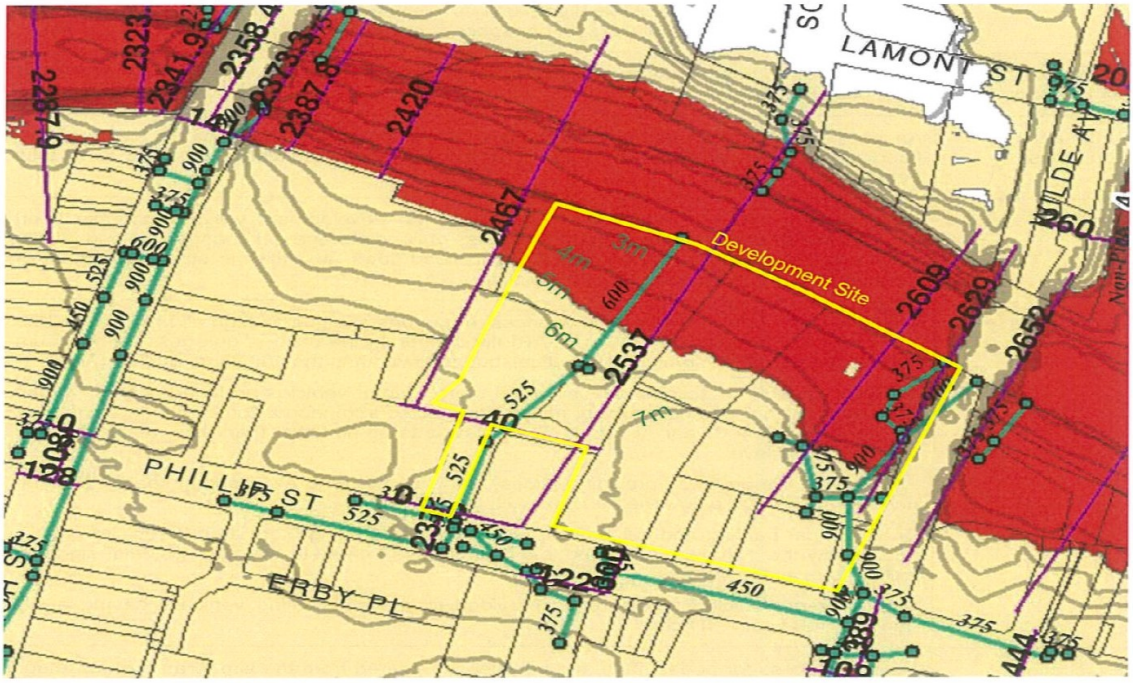


Figure 5 Extract of CPC hydraulic hazard map with ground contours labelled

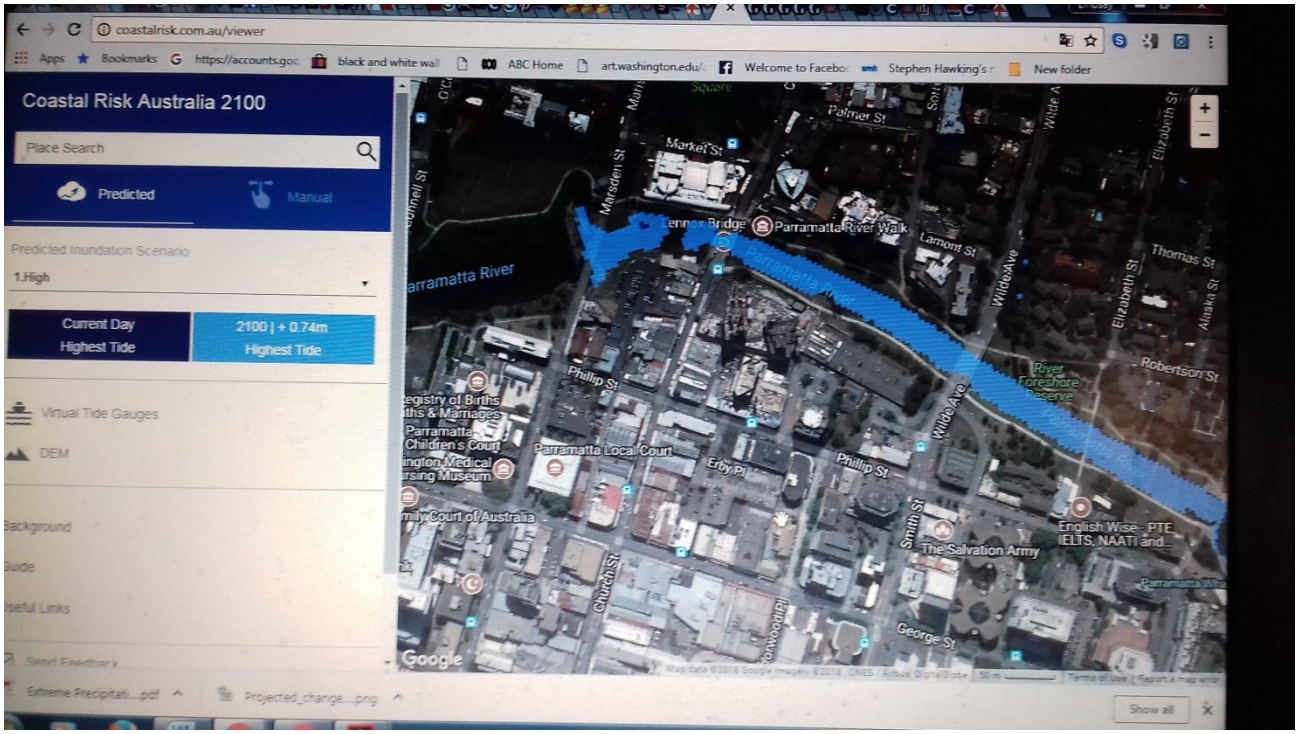
Flood Risk Precinct	Ground Level (Metres AHD)
High Flood Risk	Less than 5.00
Medium Flood Risk	5.00 to 5.95
Low Flood Risk	Above 5.95

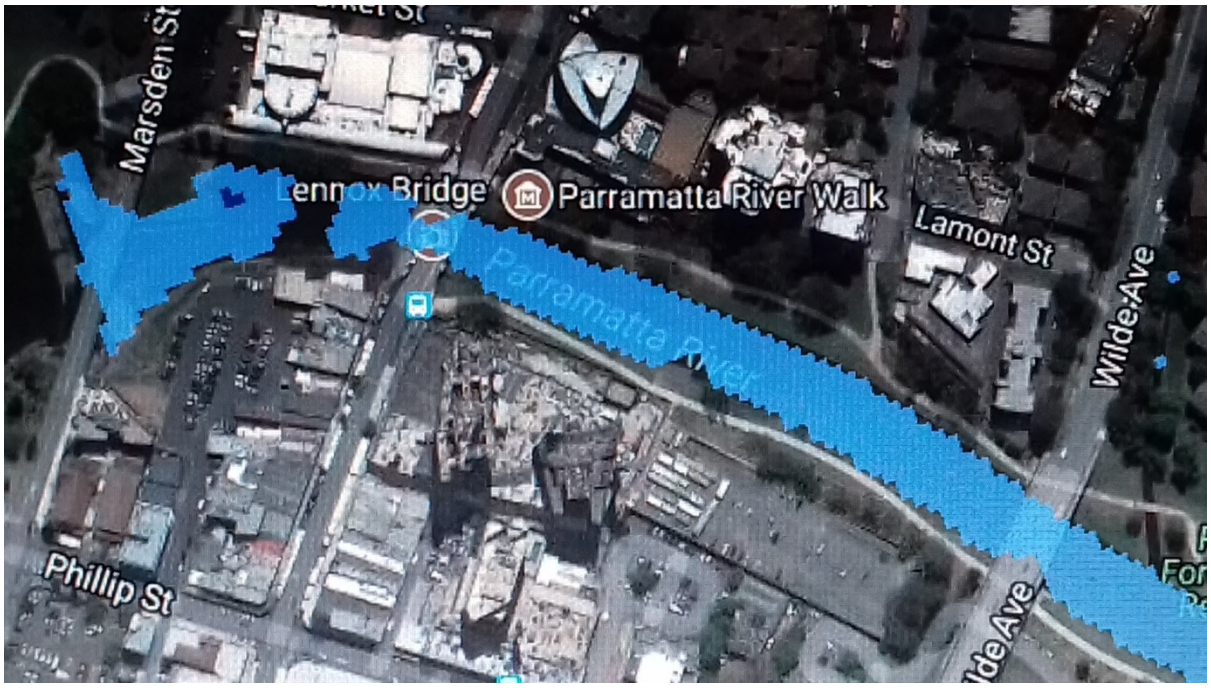
Table 3 Flood Risk Precincts within the site

6.1 Coastal Risk Assessment Australia 2100:

More certainty is creeping into this field and maps imaging Parramatta's risk profile in 2100 (maximum) indicate the river is indeed severely tidal this far up the waterway by this date, which has significant implications for the Riverbank site. These maps and supporting data are available on: coastalrisk.com.au/viewer, search 'Parramatta'. These are found as the 'predicted inundation scenario'; the first map gives a wider context the other is a close up.

There is no suggestion the complex flooding interplay of an epochal 100 year + flood event has been cross related here to a maximal (estimated) tidal/storm event. In the past when such occurrences have been exacerbated (East Anglia in the 1953/Holland, throughout history) by storm surges many lives have been lost after defences proved woefully inadequate notwithstanding the reassurance of authorities concerned. Equally, the new Queensland Art Gallery Building was flooded in the last few years with devastating effect, notwithstanding flood studies carried out by engineering experts prior to development. Combining such an epochal flood which will easily overwhelm the calming effect of the weir upstream at the west end of Philip Street/west of Marsden Street with a maximum tidal surge and a storm surge in a westerly direction may well have catastrophic and unmitigated effects on the new museum. Dr Macintosh has also rightly stressed the potential loss of life above all else.





1953 floods in North Sea:

'The 1953 North Sea flood was a major flood caused by a heavy storm that occurred on the night of Saturday, 31 January 1953 and morning of Sunday, 1 February 1953. The floods struck the Netherlands, Belgium, England and Scotland.

A combination of a high spring tide and a severe European windstorm over the North Sea caused a storm tide; the combination of wind, high tide, and low pressure led to a water level of more than 5.6 metres (18.4 ft.) above mean sea level in some locations.

The flood and waves overwhelmed sea defences and caused extensive flooding. The Netherlands, a country with 20% of its territory below mean sea level and 50% less than 1 metre (3.3 ft.) above sea level and which relies heavily on sea defences, was worst affected, recording 1,836 deaths and widespread property damage. Most of the casualties occurred in the southern province of Zeeland. In England, 307 people were killed in the counties of Lincolnshire, Norfolk, Suffolk and Essex. Nineteen were killed in Scotland. Twenty-eight people were killed in West Flanders, Belgium.'

A scenario in which there is an unprecedented, massive, recent prior rain event in the Parramatta River catchment; a maximal tidal surge pushed by easterly winds soon thereafter; and a weather depression event over Parramatta lowering air pressure over the Riverbank site is not unthinkable, especially with weather extremes being driven by climate change in the broader sense. If this happens with sea level rise already extant in the 4m to 5m band…

For the record: Dr John Macintosh is one of Australia's leading flood experts and has focused on this domain all his professional life. In a choice between his advice and that of TTW the Alliance knows which one to rely on.

6.2 Weasel Words and Rubbery Calculations in Government's report?

Right at the end of the report in between some other desiderata TTW states:

'5. Flood models for the detailed development proposals should include a sensitivity analysis with the inclusion of climate change allowance of up to 30% increase in design rainfall'. (Crabbe/Brain)

There is no apparent explanation as to why 15% is chosen to underpin this report's calculations but 30% should be utilised in the detailed design development phase. This report underpins the Business Case building cost estimates inherently rendering them unreliable and undercosted. If TTW think this work product exhibits empirical science they might need to buy a better Ouija Board or throw darts more accurately at a numeric target? There is no quoting of sources or authorities for this % age range as far as this reviewer can ascertain. Even if there was such a validated range, providing the basis for the resultant calculations,the authorities and sources require detailed interrogation/justification along with the range quoted in respect of this particular location and project.

To increase from 15% to 30% will change most if not all calculations and modelling. This will also, inevitably, affect the site and building engineering and will require even more height above the present maximum predicted flood levels.

This will flow through to most of the detailed designs at grade and first floor plus, probably, at basement levels. By increasing structural load and weight it will affect the piling. Reinforcement of spans will need to be enhanced. Heavy load access will be more challenging and so on. As the parameters and protocols derived from increasing climate change driven risks progress the building designs, which Government will try to restrict cost-wise, will inevitably change forcing cost increases.

This is already happening. Word at MAAS Board level indicates the funding envelope in 2018 dollars is no longer $655 million but in the region of $900 million and climbing. So much for this 'expert' report: perhaps outdated; inaccurate; inconsistent; unreliable; risk ridden; imprudent? Only time will tell. 'Caveat Emptor' might be the best advice.

6.3 Hansen et al:

Hansen et al.'s most recent report in the Philosophical Transactions of the Royal Society is at http://rsta.royalsocietypublishing.org/ on July 3, 2018.

The on line journal 'Resilience' had this to report after Hansen's earlier jarring expert report (2012) on potential sea level rise of 5 metres by around 2100:

'Rahmstorf (2007) made an important contribution to the sea level discussion by pointing out that even a linear relation between global temperature and the rate of sea level rise, calibrated with 20th century data, implies a 21st sea level rise of about a meter, given expected global warming for BAU greenhouse gas emissions. Vermeer and Rahmstorf (2009) extended Rahmstorf's semi-empirical approach by adding a rapid response term, projecting sea level rise by 2100 of 0.75-1.9 m for the full range of IPCC climate scenarios. Grinsted et al. (2010) fit a 4-parameter linear response equation to temperature and sea level data for the past 2000 years, projecting a sea level rise of 0.9-1.3 m by 2100 for a middle IPCC scenario (A1B). These projections are typically a factor of 3-4 larger than the IPCC (2007) estimates, and thus they altered perceptions about the potential magnitude of human-caused sea level change.

Alley (2010) reviewed projections of sea level rise by 2100, showing several clustered around 1 m and one outlier at 5 m, all of these approximated as linear in his graph. The 5 m estimate is what Hansen (2007) suggested was possible under IPCC's BAU climate forcing. Such a graph is comforting – not only does the 5-meter sea level rise disagree with all other projections, but its half-meter sea level rise this decade is clearly preposterous.

However, the fundamental issue is linearity versus non-linearity. Hansen (2005, 2007) argues that amplifying feedbacks make ice sheet disintegration necessarily highly non-linear, and that IPCC's BAU forcing is so huge that it is difficult to see how ice shelves would survive. As warming increases, the number of ice streams contributing to mass loss will increase, contributing to a nonlinear response that should be approximated better by an exponential than by a linear fit. Hansen (2007) suggested that a 10-year doubling time was plausible, and pointed out that such a doubling time, from a 1 mm per year ice sheet contribution to sea level in the decade 2005-2015, would lead to a cumulative 5 m sea level rise by 2095.'

The work of Hansen's group is controversial yet their science becomes stronger as they pursue research and linked reports. For an example of the controversy see: http://www.climatecentral.org/news/hansen-study-extreme-weather-tied-to-climate-change-14760

6.4 Feed-back loops and more rapid global warming/ice melt in Greenland and Antarctica:

In a leading exploratory article in today's Guardian the following was covered (07 08 2018)

Climate change

Domino-effect of climate events could push Earth into a 'hothouse' state

Leading scientists warn that passing such a point would make efforts to reduce emissions increasingly futile

Jonathan Watts

Tue 7 Aug 2018 05.00 AEST Last modified on Tue 7 Aug 2018 10.05 AEST

[Picture]

Polar bears on sea ice: the loss of the Greenland ice sheet could disrupt the Gulf Stream, which would in turn raise sea levels and accelerate Antarctic ice loss. Photograph: Paul Goldstein/Cover Images

A domino-like cascade of melting ice, warming seas, shifting currents and dying forests could tilt the Earth into a "hothouse" state beyond which human efforts to reduce emissions will be increasingly futile, a group of leading climate scientists has warned.

This grim prospect is sketched out in a journal paper that considers the combined consequences of 10 climate change processes, including the release of methane trapped in Siberian permafrost and the impact of melting ice in Greenland on the Antarctic.

The authors of the essay, published in Proceedings of the National Academy of Sciences, stress their analysis is not conclusive, but warn the Paris commitment to keep warming at 2C above pre-industrial levels may not be enough to "park" the planet's climate at a stable temperature.

They warn that the hothouse trajectory "would almost certainly flood deltaic environments, increase the risk of damage from coastal storms, and eliminate coral reefs (and all of the benefits that they provide for societies) by the end of this century or earlier."

Fifty years ago, this would be dismissed as alarmist, but now scientists have become really worried
Johan Rockström, executive director, Stockholm Resilience Centre

"I do hope we are wrong, but as scientists we have a responsibility to explore whether this is real," said Johan Rockström, executive director of the Stockholm Resilience Centre. "We need to know now. It's so urgent. This is one of the most existential questions in science."

Rockström and his co-authors are among the world's leading authorities on positive feedback loops, by which warming temperatures release new sources of greenhouse gases or destroy the Earth's ability to absorb carbon or reflect heat.

Sweden's highest point set to lose title as glacier melts

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Their new paper asks whether the planet's temperature can stabilise at 2C or whether it will gravitate towards a more extreme state. The authors attempt to assess whether warming can be halted or whether it will tip towards a "hothouse" world that is 4C warmer than pre-industrial times and far less supportive of human life.

Katherine Richardson from the University of Copenhagen, one of the authors, said the paper showed that climate action was not just a case of turning the knob on emissions, but of understanding how various factors interact at a global level.

"We note that the Earth has never in its history had a quasi-stable state that is around 2C warmer than the preindustrial and suggest that there is substantial risk that the system, itself, will 'want' to continue warming because of all of these other processes – even if we stop emissions," she said. "This implies not only reducing emissions but much more."

Last year was warmest ever that didn't feature an El Niño, report finds

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New feedback loops are still being discovered. A separate paper published in PNAS reveals that increased rainfall – a symptom of climate change in some regions - is making it harder for forest soils to trap greenhouse gases such as methane.

Previous studies have shown that weakening carbon sinks will add 0.25C, forest dieback will add 0.11C, permafrost thaw will add 0.9C and increased bacterial respiration will add 0.02C. The authors of the new paper also look at the loss of methane hydrates from the ocean floor and the reduction of snow and ice cover at the poles.

Rockström says there are huge gaps in data and knowledge about how one process might amplify another. Contrary to the Gaia theory, which suggests the Earth has a self-righting tendency, he says the feedbacks could push the planet to a more extreme state.

Rising ocean waters from global warming could cost trillions of dollars

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As an example, the authors say the loss of Greenland ice could disrupt the Gulf Stream ocean current, which would raise sea levels and accumulate heat in the Southern Ocean, which would in turn accelerate ice loss from the east Antarctic. Concerns about this possibility were heightened earlier this year by reports that the Gulf Stream was at its weakest level in 1,600 years.

Currently, global average temperatures are just over 1C above pre-industrial levels and rising at 0.17C per decade. The Paris climate agreement set actions to keep warming limited to 1.5C-2C by the end of the century, but the authors warn more drastic action may be necessary.

“The heatwave we now have in Europe is not something that was expected with just 1C of warming,” Rockström said. “Several positive feedback loops are already in operation, but they are still weak. We need studies to show when they might cause a runaway effect.

Underwater melting of Antarctic ice far greater than thought, study finds

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Another climate scientist – who was not involved in the paper – emphasised the document aimed to raise questions rather than prove a theory. “It’s rather selective, but not outlandish,” said Prof Martin Siegert, co-director of the Grantham Institute. “Threshold and tipping points have been discussed previously, but to state that 2C is a threshold we can’t pull back from is new, I think. I’m not sure what ‘evidence’ there is for this – or indeed whether there can be until we experience it.”

Rockström said the question needed asking. “We could end up delivering the Paris agreement and keep to 2C of warming, but then face an ugly surprise if the system starts to slip away,” he said. “We don’t say this will definitely happen. We just list all the disruptive events and come up with plausible occurrences … 50 years ago, this would be dismissed as alarmist, but now scientists have become really worried.”

“In the context of the summer of 2018, this is definitely not a case of crying wolf, raising a false alarm: the wolves are now in sight,” said Dr Phil Williamson, a climate researcher at the University of East Anglia. “The authors argue that we need to be much more proactive in that regard, not just ending greenhouse gas emissions as rapidly as possible, but also building resilience in the context of complex Earth system processes that we might not fully understand until it is too late.”

6.4 Detailed supporting notes from Mr JP Alexandre, Civil Engineer:

See accompanying Notes from Mr JP Alexandre, a hydrologically trained Civil Engineer. These notes do not take into account the latest Hansen et al. research paper but are supportive of the fundamental reasoning in the present paper and look at the sites in greater detail relating them to regulations and engineering requirements.

(LGS 07 08 2018, with thanks to GC for editing assistance, in part. All remaining mistakes are mine)