From:	Ian Dunlop
To:	IPCN Enquiries Mailbox
Subject:	Bylong Coal Project: Additional submission on Gateway Certificate issue.
Date:	Friday, 2 August 2019 10:09:29 AM
Attachments:	BT paper risk security.05.pdf BT paper third degree 150719.pdf
Importance:	High

To: Mr Gordon Kirkby
Chair
NSW Independent Planning Commission Panel
Bylong Coal Project

Dear Mr Kirby
I write in relation to your notification that the Gateway Certificate for the Bylong coal project has expired, and to subsequent legal correspondence from KEPCO.

In that context, I would like to make a short addition to my submission of 7th November 2018:
https://www.ipcn.nsw.gov.au/resources/pac/media/files/pac/project-submissions/2018/10/bylong-coal-project/20181108t120203/itd--nsw-ipc-bylong-submission-november-2018.pdf

In that submission, I concluded that the development of new coal mines such as Bylong in the current circumstances of rapidly accelerating human-induced climate change is: *"suicidal, morally and ethically bankrupt and constitutes a crime against humanity"*.

Even since that submission was lodged, that accelerating impact has become ever more obvious, with records continually broken for extreme weather events globally, Australia included, and mounting economic and social cost.

Global communities in the last few months are declaring the need to treat climate change as a genuine emergency, for the reasons I outlined in my submission and accompanying material. At the last count, 888 councils and states in 18 countries, covering some 206 million people had committed to this course of action. This includes the UK, France, Ireland, London, New York, Paris, Vancouver, Sydney, Melbourne and many more.

In addition, global civil disobedience is rapidly increasing as politicians fail in their duty to seriously address climate change, notably the schoolchildren movement and organisations such as Extinction Rebellion. These join organisations such as Lock the Gate and Stop Adani, who have been fighting to stop coal development for years.

Because of the failure of governments and corporations to act on climate change, we are now faced with the likely prospect that the lower global average temperature increase of the Paris Agreement, 1.5degC, will happen by 2030. Further, it is quite likely that we will see a temperature increase by 2050 of 3degC, which would be a world of social chaos.

This is explained in a paper my colleague David Spratt and I released in May

2019, with a foreword by Admiral Chris Barrie, former head of the Australian Defence Force: "*Existential climate-related security risk – a scenario approach",* copy attached. The paper contains a simple 3degC 2050 global scenario setting out the hard-nosed practical implications. This scenario resulted in extensive discussion globally, some considering the scenario to be entirely credible, others that it was too extreme.

Accordingly we have just released a second paper: *"The Third Degree: evidence and implications for Australia of existential climate-related security risk"* copy attached. This paper explains the basis for the original scenario in more depth, and includes a detailed 3degC 2050 scenario developed by senior US national security experts in 2007.

Both papers are also available at: https://www.breakthroughonline.org.au/papers

In the light of the information which is now available on the escalating impact of climate change, both in these papers and more widely, nobody with any degree of responsibility or concern for the future of humanity, and of future generations, either in Australia or elsewhere, can seriously support the development of any new coal projects.

Accordingly, the issue of the expired Gateway Certificate, and the legal response it has generated, should be totally irrelevant to the real issues regarding the Bylong coal project.

If the Independent Planning Commission is to fulfil its Mission and Vision of: "*delivering a high level of independence, expertise and transparency --- to ensure well executed developments that benefit the people of NSW*", what is required is a straightforward statement by the IPC that no further new coal developments, particularly Bylong, should be contemplated in NSW.

Anything less is placing the future of the NSW community in great jeopardy, which I would suggest is totally contrary to the IPC mandate.

I would be pleased to explain these conclusions further at your convenience.

Yours sincerely

Ian Dunlop
Mob: [redacted]

POLICY PAPER

Written By:
David Spratt
& Ian Dunlop

Foreword By:
Admiral Chris Barrie
AC RAN Retired

Existential climate-related security risk:

A scenario approach

MAY 2019

Breakthrough - National Centre for Climate Restoration | breakthroughonline.org.au

THE AUTHORS

David Spratt
David Spratt is a Research Director for Breakthrough National Centre for Climate Restoration, Melbourne, and co-author of *Climate Code Red: The case for emergency action.*

Ian Dunlop
Ian T. Dunlop is a member of the Club of Rome. Formerly an international oil, gas and coal industry executive, chairman of the Australian Coal Association, chief executive of the Australian Institute of Company Directors, and chair of the Australian Greenhouse Office Experts Group on Emissions Trading 1998-2000.

CONTENTS

Published by
Breakthrough - National Centre for Climate Restoration
Melbourne, Australia
breakthroughonline.org.au
info@breakthroughonline.org.au
May 2019
Updated 7 June 2017

FOREWORD

Admiral Chris Barrie, AC RAN Retired

In 2017-18, the Australian Senate inquired into the implications of climate change for Australia's national security. The Inquiry found that climate change is "a current and existential national security risk", one that "threatens the premature extinction of Earth-originating intelligent life or the permanent and drastic destruction of its potential for desirable future development".

I told the Inquiry that, after nuclear war, human-induced global warming is the greatest threat to human life on the planet. Today's 7.5 billion human beings are already the most predatory species that ever existed, yet the global population has yet to peak and may reach 10 billion people, with dire implications absent a fundamental change in human behaviour.

This policy paper looks at the existential climate-related security risk through a scenario set thirty years into the future. David Spratt and Ian Dunlop have laid bare the unvarnished truth about the desperate situation humans, and our planet, are in, painting a disturbing picture of the real possibility that human life on earth may be on the way to extinction, in the most horrible way.

In Australia recently we have seen and heard signals about the growing realisation of the seriousness of our plight. For example, young women speak of their decisions to not have children, and climate scientists admitting to depression as they consider the "inevitable" nature of a doomsday future and turn towards thinking more about family and relocation to "safer" places, rather than working on more research.

Stronger signals still are coming from increasing civil disobedience, for example over the opening up of the Galilee Basin coal deposits and deepwater oil exploration in the Great Australian Bight, with the suicidal increase in carbon emissions they imply. And the outrage of schoolchildren over their parent's irresponsibility in refusing to act on climate change.

As my colleague Professor Will Steffen has said of the climate challenge: "It's not a technological or a scientific problem, it's a question of humanity's socio-political values… We need a social tipping point that flips our thinking before we reach a tipping point in the climate system."

A doomsday future is not inevitable! But without immediate drastic action our prospects are poor. We must act collectively. We need strong, determined leadership in government, in business and in our communities to ensure a sustainable future for humankind.

In particular, our intelligence and security services have a vital role to play, and a fiduciary responsibility, in accepting this existential climate threat, and the need for a fundamentally different approach to its risk management, as central to their considerations and their advice to government. The implications far outweigh conventional geopolitical threats.

I commend this policy paper to you.

Admiral Chris Barrie, AC RAN Retired, is Honorary Professor, Strategic & Defence Studies Centre, Coral Bell School of Asia Pacific Affairs, Australian National University, Canberra. He is a member of the Global Military Advisory Council on Climate Change and was Chief of the Australian Defence Force from 1998 to 2002.

OVERVIEW

- Analysis of climate-related security threats depends significantly on understanding the strengths and limitations of climate science projections. Much scientific knowledge produced for climate policy-making is conservative and reticent.
- Climate change now represents a near- to mid-term existential threat to human civilisation. But this is not inevitable. A new approach to climate-related security risk-management is thus required, giving particular attention to the high-end and difficult-to-quantify "fat-tail" possibilities, in order to avoid such an outcome.
- This may be most effectively explored by scenario analysis. A 2050 scenario of the high-end risks is outlined in which accelerating climate- change impacts pose large negative consequences to humanity which might not be undone for centuries.
- To reduce or avoid such risks and to sustain human civilisation, it is essential to build a zero-emissions industrial system very quickly. This requires the global mobilisation of resources on an emergency basis, akin to a wartime level of response.

INTRODUCTION

> *The true worst-case scenario might be one where we don't venture out from our safe harbors of knowledge to explore the more treacherous shores of uncertainty.*
>
> — Dr Gavin Schmidt, Director of the NASA Goddard Institute for Space Studies[1]

Climate change intersects with pre-existing national security risks to function as a threat multiplier and accelerant to instability, contributing to escalating cycles of humanitarian and socio-political crises, conflict and forced migration.

Climate-change impacts on food and water systems, declining crop yields and rising food prices driven by drought, wildfire and harvest failures have already become catalysts for social breakdown and conflict across the Middle East, the Maghreb and the Sahel, contributing to the European migration crisis.

Understanding and foreseeing such events depends crucially on an appreciation of the real strengths and limitations of climate-science projections, and the application of risk-management frameworks which differ fundamentally from conventional practice.

[1] Schmidt, G. 2018. "The best case for worst case scenarios", *Real Climate*, 19 February 2019, accessed 18 March 2019, http://www.realclimate.org/index.php/archives/2019/02/the-best-case-for-worst-case-scenarios.

SCIENTIFIC RETICENCE

Climate scientists may err on the side of "least drama", whose causes may include adherence to the scientific norms of restraint, objectivity and skepticism, and may underpredict or down-play future climate changes.[2] In 2007, security analysts warned that, in the two previous decades, scientific predictions in the climate-change arena had consistently under-estimated the severity of what actually transpired.[3]

This problem persists, notably in the work of the Intergovernmental Panel on Climate Change (IPCC), whose *Assessment Reports* exhibit a one-sided reliance on general climate models, which incorporate important climate processes, but do not include all of the processes that can contribute to system feedbacks, compound extreme events, and abrupt and/or irreversible changes.[4]

Other forms of knowledge are downplayed, including paleoclimatology, expert advice, and semi-empirical models. IPCC reports present detailed, quantified, complex modelling results, but then briefly note more severe, non- linear, system-change possibilities in a descriptive, non-quantified form. Because policymakers and the media are often drawn to headline numbers, this approach results in less attention being given to the most devastating, difficult-to-quantify outcomes.

In one example, the IPCC's *Fifth Assessment Report* in 2014 projected a sea-level rise of 0.55-0.82 metre by 2100, but said "levels above the likely range cannot be reliably evaluated". By way of comparison, the higher of two US Department of Defence scenarios is a two-metre rise by 2100, and the "extreme" scenario developed by a number of US government agencies is 2.5 metres by 2100.[5]

Another example is the recent IPCC 1.5˚C report, which projected that warming would continue at the current rate of ~0.2˚C per decade and reach the 1.5˚C mark around 2040. However the 1.5˚C boundary is likely to be passed in half that time, around 2030, and the 2˚C boundary around 2045, due to accelerating anthropogenic emissions, decreased aerosol loading and changing ocean circulation conditions.[6]

[2] Brysse, K., et al. 2013, "Climate change prediction: Erring on the side of least drama?", *Global Environmental Change,* 23(1), 327-337.

[3] Campbell, K.M., et al. 2007. *The Age of Consequences: The foreign policy and national security implications of global climate change*, Washington DC, Centre for Strategic and International Studies /Center for New American Security, 9.

[4] Wuebbles, D J., et al. 2017. *Climate Science Special Report: Fourth National Climate Assessment, Volume I,* Washington DC, US Global Change Research Program, 411.

[5] Thieler, E.R. and Zervas, C. 2017. *Global and Regional Sea Level Rise Scenarios for the United States*, NOAA Technical Report NOS CO-OPS 083, Silver Spring MA, NOAA/NOS Center for Operational Oceanographic Products and Services.

[6] Xu, Y., et al. 2018. "Global warming will happen faster than we think", *Nature*, 564 (7734), 30-32; Henley, B J., and King. A.D. 2017. "Trajectories toward the 1.5˚C Paris target: Modulation by the Interdecadal Pacific Oscillation", *Geophysical Research Letters*, 44(9), 4256-62; Jacob, D., et al. 2018. "Climate Impacts in Europe Under +1.5˚C", Global Warming', *Earth's Future*, 6(2), 264-285.

EXISTENTIAL RISK

An existential risk to civilisation is one posing permanent large negative consequences to humanity which may never be undone, either annihilating intelligent life or permanently and drastically curtailing its potential.

With the commitments by nations to the 2015 *Paris Agreement*, the current path of warming is 3˚C or more by 2100. But this figure does not include "long-term" carbon-cycle feedbacks, which are materially relevant now and in the near future due to the unprecedented rate at which human activity is perturbing the climate system. Taking these into account, the Paris path would lead to around 5˚C of warming by 2100.[7]

Scientists warn that warming of 4˚C is incompatible with an organised global community, is devastating to the majority of ecosystems, and has a high probability of not being stable. The World Bank says it may be "beyond adaptation".[8] But an existential threat may also exist for many peoples and regions at a significantly lower level of warming. In 2017, 3˚C of warming was categorised as "catastrophic" with a warning that, on a path of unchecked emissions, low-probability, high-impact warming could be catastrophic by 2050.[9]

The Emeritus Director of the Potsdam Institute, Prof. Hans Joachim Schellnhuber, warns that "climate change is now reaching the end-game, where very soon humanity must choose between taking unprecedented action, or accepting that it has been left too late and bear the consequences."[10] He says that if we continue down the present path "there is a very big risk that we will just end our civilisation. The human species will survive somehow but we will destroy almost everything we have built up over the last two thousand years."[11]

Unfortunately, conventional risk and probability analysis becomes useless in these circumstances because it excludes the full implications of outlier events and possibilities lurking at the fringes.[12]

Prudent risk-management means a tough, objective look at the real risks to which we are exposed, especially at those "fat-tail" events, which may have consequences that are damaging beyond quantification, and threaten the survival of human civilisation.

Global warming projections display a "fat-tailed" distribution with a greater likelihood of warming that is well in excess of the average amount of warming predicted by climate models, and are of a higher probability than would be expected under typical statistical assumptions. More importantly, the risk lies disproportionately in the "fat-tail" outcomes, as illustrated in Figure 1.

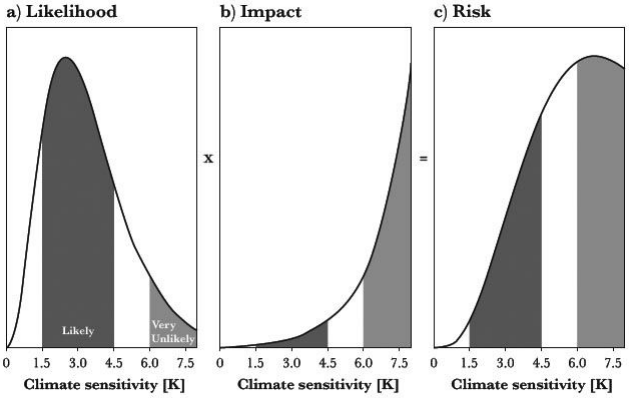

Figure 1. Schema of climate-related risk. (a) Event likelihood and (b) Impacts produce (c) Risk. Lower likelihood events at the high end of the probability distribution have the highest risk (Credit: RT Sutton/E Hawkins).

This is a particular concern with potential climate tipping-points — passing critical thresholds which result in step changes in the climate system that will be irreversible on human timescales — such as the polar ice sheets (and hence sea levels), permafrost and other carbon stores, where the impacts of global warming are non-linear and difficult to model with current scientific knowledge.

Recently, attention has been given to a "hothouse Earth" scenario, in which system feedbacks and their mutual interaction could drive the Earth System climate to a point of no return, whereby further warming would become self-sustaining. This "hothouse Earth" planetary threshold could exist at a temperature rise as low as 2˚C, possibly even lower.[13]

[7] Reilly, J., et al. 2015. *Energy and Climate Outlook: Perspectives from 2015*, Cambridge MA, MIT Program on the Science and Policy of Global Change.

[8] Spratt, D., and Dunlop, I. 2018. *What Lies Beneath: The understatement of existential climate risk*, Melbourne, Breakthrough National Centre for Climate Restoration, 14.

[9] Xu, Y., and Ramanathan, V. 2017. "Well below 2 ˚C: Mitigation strategies for avoiding dangerous to catastrophic climate changes", *Proceedings of the National Academy of Sciences,* 114(39), 10315-10323.

[10] Schellnhuber, H.J. 2018. "Foreword", in Spratt, D., and Dunlop, I. 2018, *op. cit*, 3.

[11] Breeze, N. 2018. "It's non-linearity, stupid", *The Ecologist*, 3 January 2019, accessed 18 March 2019, https://theecologist.org/2019/jan/03/its-nonlinearity-stupid

[12] Schellnhuber, H.J. 2018, *op. cit.*, 3.

[13] Steffen, W., et al. 2018. "Trajectories of the Earth System in the Anthropocene", *Proceedings of the National Academy of Sciences*, 115(33), 8252-8259.

EXISTENTIAL RISK MANAGEMENT

Because the consequences are so severe — perhaps the end of human global civilisation as we know it — "even for an honest, truth-seeking, and well-intentioned investigator it is difficult to think and act rationally in regard to… existential risks".[14] Particular issues arise: What are the plausible worst cases? And how can one tell? Are scientists self-censoring to avoid talking about extremely unpleasant outcomes? Do scientists avoid talking about the most alarming cases to motivate engagement?[15]

Analysis of climate-related security threats in an era of existential risk must have a clear focus on the extremely serious outcomes that fall outside the human experience of the last thousand years. These "fat-tail" outcomes have probabilities that are far higher than is generally understood.

Traditionally, risk is assessed as the product of probability and damage. But when the damage is beyond quantification, this process breaks down. With existential risks, learning from mistakes is not an option, and we cannot necessarily rely on the institutions, moral norms, or social attitudes developed from our experience with managing other types of risk.

What is needed now is an approach to risk management which is fundamentally different from conventional practice. It would focus on the high-end, unprecedented *possibilities,* instead of assessing middle-of-the-road *probabilities* on the basis of historic experience.

Scenario planning can overcome such obstacles, provided it is used to explore the *unprecedented possibilities,* and not simply act as a type of conventional sensitivity analysis, as is often the case in current practice. Properly applied, it can provide a framework that enables managers to better handle these critical uncertainties, avoid dangerous "group think" and provide flexible rather than unidimensional strategies, thereby potentially improving the quality of decisions in this vital arena.[16]

Existential risks require a normative view of the targets required to avoid catastrophic consequences, based on the latest science within a qualitative, moral framework. Action is then determined by the imperative to achieve the target. It requires policy that is integrated across national, regional and global boundaries, and which recognises that issues such as climate, energy, the ecological crisis and resources overuse are inextricably linked and cannot be treated in separate "silos", as at present.

In Prof. Schellnhuber's words: "We must never forget that we are in a unique situation with no precise historic analogue. The level of greenhouse gases in the atmosphere is now greater, and the Earth warmer, than human beings have ever experienced. And there are almost eight billion of us now living on this planet. So calculating probabilities makes little sense in the most critical instances… Rather, we should identify *possibilities,* that is, potential developments in the planetary makeup that are consistent with the initial and boundary conditions, the processes and the drivers we know."[17]

In this spirit, we sketch a 2050 scenario. We emphasise that this is a scenario at the high-end of the range of possibilities. It is a scenario, a way of thinking about the potential impacts that could occur, not a scientific projection of what will occur. The odds of a civilization-ending outcome are less than the odds of any single catastrophe, but the consequences of that outcome are so immense and horrible that it is important to consider what it would mean, and understand that we must take every possible step to avoid it.

[14] Bostrom, N., and Cirkovic, M.M. 2008. *Global Catastrophic Risks*, Oxford, Oxford University Press, 9.
[15] Schmidt, G. 2019, *op. cit.*
[16] Meißner, P. 2013. "The benefits of scenario-based planning" in Schwenker, B. and Wulf, T. (eds.) *Scenario-based Strategic Planning*, Weisbaden, Springer Fachmedien Weisbaden.
[17] Schellnhuber, H.J. 2018, *op. cit.,* 3.

A 2050 SCENARIO

2020–2030: Policy-makers fail to act on evidence that the current *Paris Agreement* path — in which global human-caused greenhouse emissions do not peak until 2030 — will lock in at least 3˚C of warming. The case for a global, climate-emergency mobilisation of labour and resources to build a zero-emission economy and carbon drawdown in order to have a realistic chance of keeping warming well below 2˚C is politely ignored. As projected by Xu and Ramanathan, by 2030 carbon dioxide levels have reached 437 parts per million — which is unprecedented in the last 20 million years — and warming reaches 1.6˚C.[18]

2030–2050: Emissions peak in 2030, and start to fall consistent with an 80 percent reduction in fossil-fuel energy intensity by 2100 compared to 2010 energy intensity. This leads to warming of 2.4˚C by 2050, consistent with the Xu and Ramanathan "baseline-fast" scenario.[19] However, another 0.6˚C of warming occurs — taking the total to 3˚C by 2050 — due to the activation of a number of carbon-cycle feedbacks and higher levels of ice albedo and cloud feedbacks than current models assume.

[It should be noted that this is far from an extreme scenario: the low-probability, high-impact warming (five percent probability) can exceed 3.5–4˚C by 2050 in the Xu and Ramanathan scheme.]

2050: By 2050, there is broad scientific acceptance that system tipping-points for the West Antarctic Ice Sheet and a sea-ice-free Arctic summer were passed well before 1.5˚C of warming, for the Greenland Ice Sheet well before 2˚C, and for widespread permafrost loss and large-scale Amazon drought and dieback by 2.5˚C. The "hothouse Earth" scenario has been realised, and Earth is headed for another degree or more of warming, especially since human greenhouse emissions are still significant.[20]

While sea levels have risen 0.5 metres by 2050, the increase may be 2–3 metres by 2100, and it is understood from historical analogues that seas may eventually rise by more than 25 metres.

Thirty-five percent of the global land area, and 55 percent of the global population, are subject to more than 20 days a year of lethal heat conditions, beyond the threshold of human survivability.

The destabilisation of the Jet Stream has very significantly affected the intensity and geographical distribution of the Asian and West African monsoons and, together with the further slowing of the Gulf Stream, is impinging on life support systems in Europe. North America suffers from devastating weather extremes including wildfires, heatwaves, drought and inundation. The summer monsoons in China have failed, and water flows into the great rivers of Asia are severely reduced by the loss of more than one-third of the Himalayan ice sheet. Glacial loss reaches 70 percent in the Andes, and rainfall in Mexico and central America falls by half. Semi-permanent El Nino conditions prevail.

Aridification emerges over more than 30 percent of the world's land surface. Desertification is severe in southern Africa, the southern Mediterranean, west Asia, the Middle East, inland Australia and across the south-western United States.

Impacts: A number of ecosystems collapse, including coral reef systems, the Amazon rainforest and in the Arctic.

Some poorer nations and regions, which lack capacity to provide artificially-cooled environments for their populations, become unviable. Deadly heat conditions persist for more than 100 days per year in West Africa, tropical South America, the Middle East and South-East Asia, contributing to more than a billion people being displaced from the tropical zone.

Water availability decreases sharply in the most affected regions at lower latitudes (dry tropics and subtropics), affecting about two billion people worldwide. Agriculture becomes nonviable in the dry subtropics.

[18] Xu, Y., and Ramanathan, V. 2017, *op. cit*.
[19] Xu, Y., and Ramanathan, V. 2017, *op. cit*.
[20] Data for this scenario is drawn from a wide range of sources, including: Xu, Y. and Ramanathan, V. 2017, *op. cit*.; Campbell, K.M., et al. 2007, *op cit.*; Mora, C., et al. 2017. "Global risk of deadly heat", *Nature Climate Change*, 7, 501-506; Lynas, M. 2007. *Six Degrees: Our future on a hotter planet*, London, Fourth Estate; Wallace-Wells, D. 2019. *The Uninhabitable Earth: Life after warming*, New York, Duggan Books.

Most regions in the world see a significant drop in food production and increasing numbers of extreme weather events, including heat waves, floods and storms. Food production is inadequate to feed the global population and food prices skyrocket, as a consequence of a one-fifth decline in crop yields, a decline in the nutrition content of food crops, a catastrophic decline in insect populations, desertification, monsoon failure and chronic water shortages, and conditions too hot for human habitation in significant food-growing regions.

The lower reaches of the agriculturally-important river deltas such as the Mekong, Ganges and Nile are inundated, and significant sectors of some of the world's most populous cities — including Chennai, Mumbai, Jakarta, Guangzhou, Tianjin, Hong Kong, Ho Chi Minh City, Shanghai, Lagos, Bangkok and Manila — are abandoned. Some small islands become uninhabitable. Ten percent of Bangladesh is inundated, displacing 15 million people.

Even for 2˚C of warming, more than a billion people may need to be relocated and In high-end scenarios, the scale of destruction is beyond our capacity to model, with a high likelihood of human civilisation coming to an end.[21]

National security consequences: For pragmatic reasons associated with providing only a sketch of this scenario, we take the conclusion of the *Age of Consequences* 'Severe' 3˚C scenario developed by a group of senior US national-security figures in 2007 as appropriate for our scenario too:

> Massive nonlinear events in the global environment give rise to *massive nonlinear societal events*. In this scenario, nations around the world will be *overwhelmed by the scale of change* and pernicious challenges, such as pandemic disease. The internal cohesion of nations will be under great stress, including in the United States, both as a result of a dramatic rise in migration and changes in agricultural patterns and water availability. The flooding of coastal communities around the world, especially in the Netherlands, the United States, South Asia, and China, has the potential to *challenge regional and even national identities*. Armed conflict between nations over resources, such as the Nile and its tributaries, is likely and nuclear war is possible. The social consequences range from increased religious fervor to *outright chaos*. In this scenario, climate change provokes *a permanent shift in the relationship of humankind to nature*'.[22] (emphasis added)

[21] Wariaro, V., et al. 2018. *Global Catastrophic Risks 2018*, Stockholm, Global Challenges Foundation, 24.

[22] Campbell, K.M., et al. 2007, *op. cit.*, 9.

DISCUSSION

This scenario provides a glimpse into a world of "outright chaos" on a path to the end of human civilisation and modern society as we have known it, in which the challenges to global security are simply overwhelming and political panic becomes the norm.

Yet the world is currently completely unprepared to envisage, and even less deal with, the consequences of catastrophic climate change.[23]

What can be done to avoid such a probable but catastrophic future? It is clear from our preliminary scenario that dramatic action is required this decade if the "hothouse Earth" scenario is to be avoided. To reduce this risk and protect human civilisation, a massive global mobilisation of resources is needed in the coming decade to build a zero-emissions industrial system and set in train the restoration of a safe climate. This would be akin in scale to the World War II emergency mobilisation.

There is an increasing awareness that such a response is now necessary. Prof. Kevin Anderson makes the case for a Marshall Plan-style construction of zero-carbon-dioxide energy supply and major electrification to build a zero-carbon industrial strategy by "a shift in productive capacity of society akin to that in World War II".[24] Others have warned that "only a drastic, economy-wide makeover within the next decade, consistent with limiting warming to 1.5˚C", would avoid the transition of the Earth System to the Pliocene-like conditions that prevailed 3-3 3 million years ago, when temperatures were ~3˚C and sea levels 25 metres higher.[25] It should be noted here that the 1.5˚ goal is not safe for a number of Earth System elements, including Arctic sea-ice, West Antarctica and coral reefs.

The national security sector has unrivalled experience and capacity in such mobilisation, and can play a unique role in its development and implementation, as well as educating policymakers of the existential security risks in failing to do so.

POLICY RECOMMENDATIONS

- Recognise the limitations of policy-relevant climate change research which may exhibit scientific reticence.
- Adopt a scenario approach giving specific attention to high-end warming possibilities in understanding medium-range (mid-century) climate and security risks, particularly because of the existential implications.
- Give analytical focus to the role of near-term action as a determinant in preventing planetary and human systems reaching a "point of no return" by mid-century, in which the prospect of a largely uninhabitable Earth leads to the breakdown of nations and the international order.
- Urgently examine the role that the national security sector can play in providing leadership and capacity for a near-term, society-wide, emergency mobilisation of labour and resources, of a scale unprecedented in peacetime, to build a zero-emissions industrial system and draw down carbon to protect human civilisation.

[23] Ism, C., et al. 2017. *Global Catastrophic Risks 2017*, Stockholm, Global Challenges Foundation, 35.

[24] Anderson, K. 2019. 'Climate's holy trinity: how cogency, tenacity & courage could yet deliver on our Paris 2˚C commitment', Presentation to Oxford Climate Society, 24 January 2019, accessed 18 March 2019, https://www.youtube.com/watch?v=7BZFvc-ZOa8.

[25] Burke, K.D. et al., 2018. 'Pliocene and Eocene provide best analogs for near-future climates', *Proceedings of the National Academy of Sciences*, 115 (52), 13288-13293.


BREAK
THROUGH

DISCUSSION PAPER

Written By:
David Spratt
& Ian Dunlop

The third degree:

Evidence and implications for Australia of existential climate-related security risk

JULY 2019

Breakthrough - National Centre for Climate Restoration | breakthroughonline.org.au

THE AUTHORS

David Spratt
David Spratt is a Research Director for Breakthrough National Centre for Climate Restoration, Melbourne, and co-author of *Climate Code Red: The case for emergency action.*

Ian Dunlop
Ian T. Dunlop is a member of the Club of Rome. Formerly an international oil, gas and coal industry executive, chairman of the Australian Coal Association, chief executive of the Australian Institute of Company Directors, and chair of the Australian Greenhouse Office Experts Group on Emissions Trading 1998-2000.

CONTENTS

Published by
Breakthrough - National Centre for Climate Restoration
Melbourne, Australia
breakthroughonline.org.au
info@breakthroughonline.org.au
July 2019

Research assistant: Alia Armistead

OVERVIEW

- Since the Paris climate conference in 2015, much time has been spent talking about and researching 1.5˚C to 2˚C of climate warming. But there has been relatively little focus on where the climate system is actually heading, given the lack of political commitment to climate action on a global scale: which is 3˚C of warming, and possibly much more.
- In May 2019, Breakthrough published a policy paper *Existential Climate-related Security Risk: A scenario approach*, which included a brief 3˚C scenario. Understanding scenarios is important because of the role they can play in "thinking the unthinkable", sensitizing and broadening mindsets to critical global developments, especially the unexpected, and adjusting strategy accordingly. Scenario planning does not forecast, predict or express preferences for the future; rather it is story-telling, painting internally-consistent pictures of alternative worlds which might emerge, given certain assumptions that are credible in the light of both known and lesser known factors.
- This paper provides detailed supporting evidence for the brief 3°C scenario. Some contentious aspects are explored, including the possibility that perhaps a billion people could be displaced by 3˚C or warming, that some regions may become too hot for human habitation for part of the year, and that critical thresholds, consistent with the "Hothouse Earth" scenario, may be passed.
- To complement this picture, a 3˚C scenario developed in 2007 by US national security analysts is reproduced. Its conclusions do not mince words. This scenario has proven prescient in foreseeing some of the major socio-political events that have already emerged in the 12 years since its publication. Understanding what 3˚C of warming really means should be a great motivator for climate emergency action.
- The first priority of any government is to protect its people. Climate change now represents the greatest threat to that security, far outweighing conventional geopolitical threats.
- Likewise, company boards have a fiduciary responsibility to ensure the viability of their organisations, and manage the threats they face, in the interests of shareholders, customers and community.
- Yet the "Official Future" in Australia for the last two decades, subscribed to by the majority of political and corporate leaders, has been, and remains, climate denial and predatory delay.
- Because of this complacent, group-think leadership failure, the Australian community is totally unprepared for the climate impacts which are already causing havoc across the continent, and which will escalate. The threat is not new, having been foreshadowed by the scientific community for decades. In this context, such attitudes represent nothing less than criminal negligence by our political and corporate incumbency.
- Holistic scenario planning on the real implications of climate change for Australia, encompassing the full range of possible futures, must be initiated as a matter of extreme urgency. We must rapidly rethink our "Official Future" before events move beyond our ability to influence outcomes. From now on policy must protect the future from the past, not the past from the future.
- To gain community support for the massive economic and social changes ahead, the outcomes of such analysis must become normalised in our thinking, socialised in everyday discussion, and become the basis for planning and action.
- Now is the time for our new Parliament, and corporate leaders, to change direction and demonstrate they have the wisdom and leadership the Australian community deserve.

"From now on policy must protect the future from the past, not the past from the future."

INTRODUCTION

Since the Paris climate conference in 2015, much time has been devoted to scenarios for 1.5˚C to 2˚C of climate warming. That's not surprising, because limiting warming to the range of 1.5–2˚C was the Paris goal, and there has since been the 2018 special IPCC report on 1.5˚C.

What hasn't been spelt out clearly is that 1.5˚C is not a good outcome: it would mean coral systems reduced to fragments, a multi-metre sea-level rise on the way, Pacific nations drowned, more lethal extreme weather, and glaciers in Antarctica passed their tipping points, just for starters.

But there is another problem about the recent discussion: there has been relatively little focus on where the climate system is actually heading, given the lack of political commitment to climate action on a global scale. And that is warming of 3˚C, and possibly much more.

Understanding what 3˚C of warming really means should be a great motivator for climate emergency action. But much of the political apparatus, the business sector and the community don't have a good understanding of the third degree.

In May 2019, Breakthrough published a policy paper *Existential Climate-related Security Risk: A scenario approach*, which received a large amount of media coverage. This included the major US network sites, plus CNN and Al Jazeera, magazines such as *New Scientist* and *GQ,* newspapers including *The Guardian* and *The Independent*, sites such as Vox, many radio interviews, and significant coverage in Europe, especially in Germany and Scandinavia. It was far more engagement that we possibly imagined when the paper was released, because we thought that there wasn't all that much new in the story of a 3˚C-warmer world.

As far back as 2007, the *Age of Consequences* report from US national security experts had painted a grim picture of that future.[1] Yet it seems the story was little understood.

The Breakthrough paper argued that analysis of climate-related security threats depends significantly on understanding the strengths and limitations of climate science projections, but much scientific knowledge produced for climate policy-making is conservative and reticent, as discussed in the 2018 Breakthrough report, *What Lies Beneath*.[2]

When properly considered, climate change now represents a near- to mid-term existential threat to human civilisation. However, this is not inevitable. A new approach to climate-related security risk management is required, giving particular attention to the high-end and difficult-to-quantify "fat-tail" possibilities, in order to avoid such an outcome.

This may be most effectively explored by scenario analysis. In the policy paper, a brief outline of a 2050 scenario of 3˚C of warming and a 0.5 metre sea level rise is explored in order to illustrate the high-end risks, in which accelerating climate-change impacts pose large negative consequences to humanity which might not be undone for centuries.

To reduce or avoid such risks and to sustain human civilisation, it is essential to build a zero-emissions industrial system very quickly. This requires the global mobilisation of resources on an emergency basis, akin to a wartime level of response.

This followup discussion paper provides detailed background to that scenario by reproducing it, now annotated with footnotes to explain the basis and sources for the analysis.

As well, we reproduce here the 3˚C scenario from *The Age of Consequences* analysis. This adds new perspectives to the brief Breakthrough scenario.

There should be clarity about the term "existential threat" used in the Breakthrough policy paper. Despite some over-the-top media coverage when it was released, the paper does not talk about human extinction in any shape or form, nor is it implied. In fact the scenario discusses the high numbers of people (billions) who will be affected one way or another, hardly circumstances consistent with a human species extinction event.

[1] Campbell, K.M, et al., 2007, *The Age of Consequences: The foreign policy and national security implications of global climate change*, Centre for Strategic and International Studies and Centre for New American Security, Washington.

[2] Spratt, D, & Dunlop, I 2018, *What Lies Beneath: The understatement of existential climate risk*, Breakthrough National Centre for Climate Restoration, Melbourne.

As discussed in the paper, the term "existential" threat or risk is applied to human *civilisation*, not humans as a *species*, consistent with the definition of the term as including events which would "permanently and drastically curtailing its potential", in this case human civilisation/culture. This is consistent with Prof. Hans Joachim Schellnhuber's statement that if we continue down the present path "there is a very big risk that we will just *end our civilisation*. The human species will survive somehow but we will destroy almost everything we have built up over the last two thousand years" (emphasis added).[3]

There were also claims that the paper is exaggerated and alarmist. Any scenario is, by its nature, somewhat speculative. Interestingly, that same criticism did not apply when the UN Secretary General António Guterres recently said: "So we are losing the race, climate change is running faster than we are, and we need to sound the alarm, this is an emergency, this is a climate crisis and we need to act now. Unfortunately in politics, there is always a huge trend to keep the status quo. The problem is that the status quo is a *suicide*" (emphasis added).[4] UNFCCC Head, Patricia Espinoza, re-iterated the call for emergency action at the recent Bonn climate discussions.[5]

Published research suggests that life in Australia would be turned upside down due to severe climate impacts if the world were to warm by 3°C, including more deaths from extreme heat waves,[6] the need to retreat from low-lying coastal areas, severe impacts on food production, including in the Murray-Darling Basin, the loss of the Great Barrier Reef, the drying of much of the sub-tropical zone, and much more.

The impacts will be even more severe in Australia's neighbourhood, the Indo-Pacific region, where the economic capacity to adapt is lower. Significant areas will be inundated as sea levels rise and some smaller countries will drown, hundreds of millions of people are likely to be displaced for one reason or another, and there will be severe water crises in some of the most populous countries — including China, India and Pakistan. States will fail.

Yet that is precisely the path we are on now, even taking the *Paris Agreement* commitments into account. In fact, warming could be a good bit higher that 3°C. This suggests that as a matter of priority comprehensive scenarios should be developed for Australia and its near region so that Australian policy-makers are well-informed about the fateful choices they are now making.

[3] Breeze, N, 2018, "It's non-linearity, stupid", *The Ecologist*, 3 January 2019.

[4] Pyper, J, 2019, "UN Chief Guterres: The status quo on climate policy 'is a suicide'", *Greentechmedia*, 7 June 2019,

[5] UNFCCC, 2019, "UN Climate Chief Urges Action on Climate Emergency", United Nations Climate Change, 18 June 2019, https://unfccc.int/news/un-climate-chief-urges-action-on-climate-emergency.

[6] Lloyd, S, 2019, "Temperature rises will make Brisbane a "difficult place to live' within 30 years, report finds", *ABC News*, 22 June 2019.

UNDERSTANDING SCENARIOS

As the complexity of the issues facing business, government and society mount, scenario planning has become an increasingly popular technique. It is rare to find a policy or economic report these days which does not claim to incorporate some form of scenario analysis.

The technique, properly used, is powerful, but sadly the term has become somewhat devalued and much of the work that purports to be scenario analysis represents little more than sensitivities around some conventional strategic plan. That is the case with climate change policy, both in Australia and globally.

Scenario planning had its genesis in the early days of the Cold War when futurist Herman Kahn and colleagues at the Rand Corporation developed the technique to "think the unthinkable" in regard to possible outcomes of nuclear deterrence. It was subsequently adopted by business, particularly by Royal Dutch Shell, to sensitize and broaden mindsets to critical global developments, especially the unexpected, and to adjust corporate strategy accordingly.

Scenarios are coherent, credible stories about alternative futures. They are created around a synthesis of multiple, wide-ranging, perspectives on a particular problem, rather than detailed development of a single viewpoint. Scenario planning does not forecast, predict or express preferences for the future; rather the story-telling paints internally-consistent pictures of alternative worlds which might emerge given certain assumptions, that are credible in the light of both known and lesser known factors.

Strategy is then assessed against each possible future. Some elements of strategy will be common under all scenarios, but others will differ markedly; the final strategic choice being made in the light of the organization's preferences, but with a better understanding of the possible risks the future might hold whichever world actually eventuates. Contingency plans can then be developed to manage those risks.

One of the key tasks in initiating a scenario planning exercise is to identify the "Official Future": the future as it is supposed to be, and upon which prevailing strategy is based. Inevitably there is a large amount of "political" capital tied up in that view, often a result of group-think generated by dominant individuals, or ideology, which nobody is prepared to contest, or by business or political models which have stood the test of time but which may be ill-equipped for the future as it might unfold.

A great advantage of the technique, given that it is setting out to explore but not predict the future, is that, if done properly in a non-threatening manner, it allows for constructive discussion on alternatives taking into account the full range of credible evidence. In particular, there must be a preparedness to "think the unthinkable", beyond conventional wisdom. Once those perspectives are available and understood by the key players, a re-assessment of the Official Future is often inevitable and undertaken proactively.

And so it is with climate change policy. In Australia, the Official Future for the last two decades, has been, and remains, climate denial and delay.

Views have become incredibly polarized, based primarily on the dominance of short-term thinking in business, political expediency and blinkered ideology. The science is ignored and key advice sidelined. Policy, such as it is in Australia, reflects a desire to stay within our comfort zone, using predatory delay to prolong the life of our high-carbon economy as long as possible for short-term financial gain, irrespective of the damage it may do to the community. So wholly inadequate emission reductions, of 26-28% by 2030, are seen to be a "challenging" task. "Unthinkable" futures, for example that those targets might have to be much stronger because the world may heat to 1.5C by 2030, as the latest science suggests, are not entertained. Too much credence is given to the denialist view that climate change is a non-problem, and if anything is done at all, it should be to wait and adapt.

The global Official Future is changing rapidly as climate impacts and associated costs escalate. Leaders and institutions such as the International Energy Agency, the World Economic Forum, the World Bank, the International Monetary Fund, Academies of Science and the United Nations — along with governments in the UK, Ireland, Canada, France and Catalonia, and cities such as New York, London and Sydney, under pressure from their communities — are calling for emergency action if catastrophic climate outcomes are to be avoided. The implication is that radically different steps must be taken if the world is to seriously address the issue.

Australia's national government needs to undertake serious scenario planning, and develop contingencies for the inevitability that our Official Future of continued high-carbon, export-led growth will fall apart, probably sooner rather than later.

We have innumerable attractive options if only we can move away from the current denialist group-think. The simple scenario presented here is an initial contribution to aid that thinking.

.

A 3°C SCENARIO EXPLORED

This section contains unamended extracts from the policy paper "Existential Climate-related Security Risk: A scenario approach" *on existential risk, and the brief scenario, together with annotated footnotes to explore some aspects in more detail. The policy papler is available at: breakthroughonline.org.au/papers.*

EXISTENTIAL RISK

An existential risk to civilisation is one posing permanent large negative consequences to humanity which may never be undone, either annihilating intelligent life or permanently and drastically curtailing its potential.[7]

Accounting for the commitments by nations to the 2015 *Paris Agreement*, the current path of warming is more than 3°C by 2100.[8] But this figure does not include "long-term" carbon-cycle feedbacks, which are materially relevant now and in the near future due to the unprecedented rate at which human activity is perturbing the climate system.[9] Taking these into

[7] This definition is from Prof. Nick Bostrom. It should be noted that it is not just about the risk of extinction of a species but also about *permanently and drastically curtailing its potential*. Bostrom says "Some scenarios in which humanity survives would also be existential catastrophes if they involve a permanent and drastic destruction of humanity's future potential" (Bostrom, N, n.d., "Frequently asked questions": https://www.existential-risk.org/faq.html).

[8] Climate interactive shows current Paris commitments at June 2019 are a path of 3.3°C of warming, without some feedbacks being included (ClimateInteractive, 2019, "Climate Scoreboard", climateinteractive.org/programs/scoreboard, accessed 20 June 2019).

[9] For example, in the 2017 *Fourth National Climate Assessment,* US government agencies found that "positive feedbacks (self-reinforcing cycles) within the climate system have the potential to accelerate human-induced climate change and even shift the Earth's climate system, in part or in whole, into new states that are very different from those experienced in the recent past", and whilst some feedbacks and potential state shifts can be modelled and quantified, "others can be modeled or identified but not quantified and some are probably still unknown". Hence: "While climate models incorporate important climate processes that can be well quantified, they do not include all of the processes that can contribute to feedbacks, compound extreme events, and abrupt and/or irreversible changes. For this reason, future changes outside the range projected by climate

account, the Paris path would lead to around 5˚C of warming by 2100.[10]

Scientists warn that warming of 4˚C is incompatible with an organised global community, is devastating to the majority of ecosystems, and has a high probability of not being stable.[11] The World Bank says it may be "beyond adaptation".[12] But an existential threat may also exist for many peoples and regions at a significantly lower level of warming. In 2017, 3˚C of warming was categorised as "catastrophic" with a warning that, on a path of unchecked emissions, low-probability, high-impact warming could be catastrophic by 2050.[13]

The Emeritus Director of the Potsdam Institute, Prof. Hans Joachim Schellnhuber, warns that "climate change is now reaching the end-game, where very soon humanity must choose between taking unprecedented action, or accepting that it has been left too late and bear the consequences."[14] He says that if we continue down the present path "there is a very big risk that we will just end our civilisation. The human species will survive somehow but we will destroy almost everything we have built up over the last two thousand years."[15]

A 2050 SCENARIO

2020–2030: Policy-makers fail to act on evidence that the current *Paris Agreement* path — in which global human-caused greenhouse emissions do not peak until 2030 — will lock in at least 3˚C of warming.[16] The case for a global, climate-emergency mobilisation of labour and resources to build a zero-emission economy and carbon drawdown in order to have a realistic chance of keeping warming well below 2˚C is politely ignored. As projected by Xu and Ramanathan, by 2030 carbon dioxide levels have reached 437 parts per million — which is unprecedented in the last 20 million years — and warming reaches 1.6˚C.[17]

2030–2050: Emissions peak in 2030, and start to fall consistent with an 80 percent reduction in fossil-fuel

models cannot be ruled out. Moreover, the systematic tendency of climate models to underestimate temperature change during warm paleoclimates suggests that climate models are more likely to underestimate than to overestimate the amount of long-term future change." (USGCRP, 2017, *Climate Science Special Report: Fourth National Climate Assessment, Volume I,* US Global Change Research Program, Washington, DC.)

[10] Reilly, J, et al,. 2015, *Energy and Climate Outlook: Perspectives from 2015*, MIT Program on the Science and Policy of Global Change, Cambridge MA,

[11] For example, Prof. Kevin Anderson says a 4˚C future is "incompatible with an organized global community, is likely to be 'beyond adaptation', is devastating to the majority of ecosystems, and has a high probability of not being stable" (Roberts, D, 2011, "The brutal logic of climate change", *Grist*, 6 December 2011).

[12] World Bank, 2012, *Turn Down the Heat: Why a 4˚C warmer world must be avoided*, World Bank, New York.

[13] Xu, Y, & Ramanathan, V, 2017, "Well below 2˚C: Mitigation strategies for avoiding dangerous to catastrophic climate changes", *Proceedings of the National Academy of Sciences,* 114, 10315-10323.

[14] Schellnhuber, H.J, 2018, "Foreword", in Spratt, D, and Dunlop, I, 2018, *What Lies Beneath: The understatement of existential climate risk*, Breakthrough National Centre for Climate Restoration, Melbourne..

[15] Breeze, N, 2018, op. cit.

[16] The last time atmospheric carbon dioxide (CO_2) emissions were at the current level, of around 400 ppm CO_2, was during the early-to-mid Pliocene 3–4 million years ago, when temperatures were around 3–4˚C warmer than pre-industrial (Pagani, M, et al., 2010, "High Earth-system climate sensitivity determined from Pliocene carbon dioxide concentrations", *Nature Geoscience*, 3, 27-29). Burke et al. say under the present high-emissions trajectory (RCP8.5) that "by 2030 CE, future climates most closely resemble Mid-Pliocene climates", and even under RCP4.5, "climate stabilizes at Pliocene-like conditions by 2040 CE". Pliocene-like conditions that prevailed 3–3.3 million years ago are described as temperatures being ~3˚C warmer than pre-industrial and sea levels 25 metres higher (Burke, KD., et al., 2018, "Pliocene and Eocene provide best analogs for near-future climates", *Proceedings of the National Academy of Sciences*, 115, 13288-13293).

[17] Xu, Y, & Ramanathan, V, 2017, op. cit. A number of other papers suggest the global average warming trend will reach 1.5˚C by around 2030, including: Henley, B.J, and King, A.D, 2017, "Trajectories toward the 1.5˚C Paris target: Modulation by the Interdecadal Pacific Oscillation", *Geophysical Research Letters*, 44, 4256-62; and Jacob, D, et al., 2018, "Climate impacts in europe under +1.5˚C global warming", *Earth's Future*, 6, 264-285. There is also the issue of the underestimation of current warming: the effect of calculating (1) warming for total global coverage rather than for the coverage for which observations are available, (2) warming using SATs over the entire globe instead of the observational blend of SSTs and SATs, and (3) warming from a pre-industrial, instead of a late-nineteenth century baseline, which together add approximately 0 3˚C to the estimate in IPCC (Schurer, A.P, et al., 2018, "Interpretations of the Paris climate target", *Nature Geoscience*, 11, 220-221).

energy intensity by 2100 compared to 2010 energy intensity. This leads to warming of 2.4˚C by 2050, consistent with the Xu and Ramanathan "baseline-fast" scenario.[18] However, another 0.6˚C of warming occurs — taking the total to 3˚C by 2050 — due to the activation of a number of carbon-cycle feedbacks and higher levels of ice albedo and cloud feedbacks than current models assume.[19]

It should be noted that this is far from an extreme scenario: the low-probability, high-impact warming (five percent probability) can exceed 3.5–4˚C by 2050 in the Xu and Ramanathan scheme.[20]

2050: By 2050, there is broad scientific acceptance that system tipping-points for the West Antarctic Ice Sheet[21] and a sea-ice-free Arctic summer[22] were passed well before 1.5˚C of warming, for the Greenland Ice Sheet[23] well before 2˚C, and for widespread permafrost loss[24] and large-scale Amazon drought and dieback[25] by 2.5˚C. The "Hothouse Earth" scenario has been realised, and Earth is headed for another degree or more of warming, especially since human greenhouse emissions are still significant.[26]

---

[18] Xu, Y., & Ramanathan, V., 2017, op. cit.

[19] Xu and Ramanthan (2017) say that taking into account the biogeochemical feedbacks (such as less efficient land/ocean sinks, permafrost loss) effectively increases the baseline-fast carbon emissions by ~20% and can enhance warming by up to 0.5˚C. As well, models may underestimate positive ice albedo feedback from the retreat of Arctic sea ice, positive cloud albedo feedback from retreating storm track clouds in mid-latitudes, and positive albedo feedback by the mixed-phase clouds. Another issue is the higher warming for the current trajectory of greenhouse gas levels that may be implied by work-in-progress on the next generation of climate models, which are so far exhibiting a higher climate sensitivity than is currently assumed (Voosen, P, 2019, "New climate models predict a warming surge", *ScienceMag,* 16 April 2019).

[20] Xu, Y, Ramanathan, V, 2017, op. cit.

[21] Rignot, E, et al., 2014, "Widespread, rapid grounding line retreat of Pine Island, Thwaites, Smith, and Kohler glaciers, West Antarctica, from 1992 to 2011", *Geophysical Research Letters*, 41, 3502–3509. NASA's Jet Propulsion Laboratory reported in May 2014 that: "A new study by researchers… finds a rapidly melting section of the West Antarctic Ice Sheet appears to be in an irreversible state of decline, with nothing to stop the glaciers in this area from melting into the sea. The study presents multiple lines of evidence, incorporating 40 years of observations that indicate the glaciers in the Amundsen Sea sector of West Antarctica 'have passed the point of no return', according to glaciologist and lead author Eric Rignot of UC Irvine and NASA's Jet Propulsion Laboratory in Pasadena, California." (NASA JPL, 2014, "West Antarctic glacier loss appears unstoppable", 12 May 2014, www.jpl.nasa.gov/news/news.php?release=2014-148.)

[22] "The chance that there will be any permanent sea ice left in the Arctic after 2022 is essentially zero… Can we lose 75-80 percent of permanent ice and recover? The answer is no," James Anderson, Harvard University professor of atmospheric chemistry, told *Forbes* on 15 January 2018 (McMahon, J, 2015, "We have five years to save ourselves from climate change, Harvard scientist says", *Forbes*, 15 January 2018). Amongst many other expert elicitations, see Tim Lenton's assessment from 2012 (Pearce, F, 2012, "Arctic sea ice may have passed crucial tipping point", *New Scientist*, 27 March 2012).

[23] Researchers estimate the tipping point for Greenland Ice Sheet as 1.6˚C, with an uncertainty range of 0.8 to 3.2˚C (Robinson, A, et al., 2012, "Multistability and critical thresholds of the Greenland ice sheet", *Nature Climate Change,* 2, 429–432); see also Bevis, M, et al., 2019, "Accelerating changes in ice mass within Greenland, and the ice sheet's sensitivity to atmospheric forcing", *Proceedings of the National Academy of Sciences*, 116, 1934-1939.

[24] Simulations suggest that between 225 and 345GtC (10th to 90th percentile) are in thawed permafrost and may eventually be released to the atmosphere for stabilization target of 2˚C (Burke, E.J, et al., 2018, "CO2 loss by permafrost thawing implies additional emissions reductions to limit warming to 1.5 or 2˚C", *Environmental Research Letters*, 13, 024024). Some scientists consider that 1.5˚C appears to be something of a "tipping point" for extensive permafrost thaw (Vaks, A. et al., 2013, "Speleothems reveal 500,000-year history of Siberian permafrost", *Science,* 340, 183-186).

[25] "We believe that negative synergies between deforestation, climate change, and widespread use of fire indicate a tipping point for the Amazon system to flip to non-forest ecosystems in eastern, southern and central Amazonia at 20-25% deforestation. The severity of the droughts of 2005, 2010 and 2015-16 could well represent the first flickers of this ecological tipping point. These events, together with the severe floods of 2009, 2012 (and 2014 over SW Amazonia), suggest that *the whole system is oscillating*" (Lovejoy, T.L, and Nobre, C, 2018, "Amazon Tipping Point", *Science Advances*, 4, eaat2340) (emphasis added). The drying of the Amazon basin may become so severe than in some models rainfall decreases to zero and the area becomes essentially desert (for more, see Lynas, M, 2007, *Six Degrees*, Fourth Estate, London, p. 130).

[26] The "Hothouse Earth" scenario is one in which system feedbacks and their mutual interaction could drive the Earth System climate to a 'point of no return',

While sea levels have risen 0.5 metres by 2050, the increase may be 2–3 metres by 2100,[27] and it is understood from historical analogues that seas may eventually rise by more than 25 metres.[28]

Thirty-five percent of the global land area, and 55 percent of the global population, are subject to more than 20 days a year of lethal heat conditions, beyond the threshold of human survivability.[29]

The destabilisation of the Jet Stream[30] has very significantly affected the intensity and geographical distribution of the Asian and West African monsoons[31] and, together with the further slowing of the Gulf Stream[32], is impinging on life support systems in Europe[33]. North America suffers from devastating

---

whereby further warming would become self-sustaining (without further human perturbations). This threshold could exist at a temperature rise as low as 2˚C (Steffen, W, et al., 2018, "Trajectories of the Earth System in the Anthropocene", *Proceedings of the National Academy of Sciences*, 115, 8252-8259). Steffen told *The Guardian*: "I think the dominant linear, deterministic framework for assessing climate change is flawed, especially at higher levels of temperature rise. So, yes, model projections using models that don't include these processes indeed become less useful at higher temperature levels. Or, as my co-author John Schellnhuber says, we are making a big mistake when we think we can 'park' the Earth System at any given temperature rise – say 2˚C – and expect it to stay there" (Readfearn, G, 2018, "Earth's climate monsters could be unleashed as temperatures rise", *The Guardian*, 6 October 2018).

[27] "Our findings support the use of scenarios of 21st century global total sea-level rise exceeding 2 metre for planning purposes" (Bamber, J.L, et al., 2019, "Ice sheet contributions to future sea-level rise from structured expert judgment", *Proceedings of the National Academy of Sciences*, 116, 11195-11200).

[28] Rohling, E.J, et al., 2009, "Antarctic temperature and global sea level closely coupled over the past five glacial cycles", *Nature Geoscience,* 2, 500–504.

[29] The phrase "beyond the threshold of human survivability" could more aptly say "beyond survivability for the most vulnerable and exposed". The 35% and 55% figures are based on Mora, C, et al. (2017. "Global risk of deadly heat", *Nature Climate Change*, 7, 501-506) who find that at 2˚C approx. 26% of land area and 48% of global population are subject to "deadly heat"; at 4˚C the figures are 47% and 74%. The authors define "deadly" as "climatic conditions that are projected to cause death", based on analysis of climate conditions during past, documented cases of excess mortality. That is, heat stress conditions which have caused mortality amongst the more vulnerable or exposed members of the population. This is a lower level of threat than exceedance of the 35˚C Wet Bulb Temperature mark, discussed in footnote 45 below. According to Xu and Ramanathan (2017) deadly heat is defined as "exceeding a threshold of temperature as well as humidity" which "*could* pose existential risks to humans and mammals alike unless adaptation measures are implemented, such as providing air conditioning to the entire population or a massive relocation of most of the population to safer climates". There is "the likelihood of approximately half of the population exposed to deadly heat by 2050" (Ramanathan, V, et al., 2018, "Climate extremes and global health', *Foreign Affairs*, 31 July 2018).

[30] Climate change and the severe loss of summertime Arctic sea ice enhance Northern Hemisphere jet stream meandering, intensifying Arctic air mass invasions toward middle latitudes such as the cold air outbreaks in Central Europe and North America in winter, and increasing the frequency of atmospheric blocking events like the one that steered Hurricane Sandy west into the densely populated New York City area. In the summer, a weakened Jet Stream leads to prolonged heat waves and dry conditions, like those experienced in Europe, for example in 2003, 2006, 2015 and 2018 (Alfred Wegener Institute, 2019, "A warming Arctic produces weather extremes in our latitudes", *PhysOrg*, 29 May 2019), and in 2019.

[31] There has been a shift westward of the Indian summer monsoon, and rainfall has become more variable. In West Africa, the long drying trend in the Sahel is related primarily to anomalies in the months of August and September, which are considered to be the peak monsoon season. As well, "Several studies have concluded that 3 to 5˚C global warming is likely to be the threshold for tipping points such as the… collapse of the West African monsoon" (Xu, Y, & Ramanathan, V, 2017, op. cit.).

[32] The Gulf Stream, more properly the Atlantic Meridional Overturning Circulation (AMOC), which has been weakening for several centuries, has slowed 15% since the mid-20th century (Caesar, L, et al., 2018, "Observed fingerprint of a weakening Atlantic Ocean overturning circulation", *Nature* 556, 191-196), and the rate of change is accelerating, with climate models projecting further slow down. The near-term loss of summer Arctic sea ice will drive an accelerating rate of ice mass loss from Greenland, and contribute to a further slowdown of AMOC. An AMOC slowdown would reduce regional warming a little, especially in Europe, but would also lead to a reduction of ocean carbon dioxide uptake, and thus an acceleration of global-scale warming (USGCRP, 2017, op cit.).

[33] In Europe, the destabilisation of the Jet Steam will contribute to prolonged heat waves and dry conditions with blazing summers, lethal heartwaves and more intense wildfires, and droughts, impacting food production. As one example, the 2003 European heat wave led to about 70,000 premature mortalities (Robine, J.M, et al., 2008, "Death toll exceeded 70,000

weather extremes including wildfires, heatwaves, drought and inundation.[34] The summer monsoons in China have failed[35], and water flows into the great rivers of Asia are severely reduced by the loss of more than one-third of the Himalayan ice sheet[36]. Glacial loss reaches 70 percent in the Andes[37], and rainfall in Mexico and central America falls by half.[38] Semi-permanent El Nino conditions prevail.[39]

in Europe during the summer of 2003", *Comptes Rendus Biologies*, 331, 171–178). In August 2010, anomalous forest fires in Russia wiped out a quarter of the grain crop, prompting the country to ban all wheat exports, which together with a drought in China that reduced wheat yields, drove up the cost of wheat on the world market. This price spike contributed to the "Arab Spring" revolt across the Middle East and North Africa, which is the region of the world most dependent on grain imports.

[34] "More frequent and intense extreme weather and climate-related events, as well as changes in average climate conditions, are expected to continue to damage infrastructure, ecosystems, and social systems that provide essential benefits to communities. Future climate change is expected to further disrupt many areas of life, exacerbating existing challenges to prosperity posed by ageing and deteriorating infrastructure, stressed ecosystems, and economic inequality… Extreme weather and climate-related impacts on one system can result in increased risks or failures in other critical systems, including water resources, food production and distribution, energy and transportation, public health, international trade, and national security. The full extent of climate change risks to interconnected systems, many of which span regional and national boundaries, is often greater than the sum of risks to individual sectors." (USGCRP, 2017, op cit.)

[35] This part of the scenario may seem an outlier, but a 3˚C-warmer world may be characterised by semi-permanent El Nino conditions (see footnote 39 below). The El Niño–Southern Oscillation has been recognized as a major factor of the year-to-year variability of the East Asian monsoon. Anomalous dry conditions over southeastern China seem to occur during central Pacific El Niños, and crop production trends may experience a reduction and instability in some regions (Yuan, Y, and Yang, S, 2012, "Impacts of different types of El Niño on the East Asian climate: Focus on ENSO Cycles", *Journal of Climate*, 25, 7702–7722).

[36] In fact, the "one-third" figure seems too conservative. As glaciers melt the regions bounding the Indus and Ganges, rivers will experience severe flooding, but that trend is likely to shift into reverse in the second half of the century and floods will be replaced by shrinkage in water flow to around 1.9 billion people who live along those rivers (Temple, J, 2019, "India's water crisis is already here. Climate change will compound it", MIT Technology Review, 24 April 2019). The inland backflow of salt water, caused by higher sea levels, will contaminate low-lying, fertile delta regions. Declassified US spy satellite images from the mid-1970s have allowed researchers to determine that the glaciers may have lost as much as a quarter of their mass over the last four decades, the rate is accelerating, and the yearly loss since 2000 has been about 1%. If these trends continue and the rate of loss continues to rise, more than half the ice sheet will be lost by 2050, perhaps up to two-thirds (Maurer, J.M, et al., 2019, "Acceleration of ice loss across the Himalayas over the past 40 years", *Science Advances*, 5, eaav7266; ABC/AP, 2019, "Cold War spy satellite images show Himalayan glaciers are melting fast' , *ABC News,* 20 June 2019). Glaciologist Lonnie Thompson of Ohio State University told an Asia Society conference in 2009 that if melting continued at current levels, two-thirds of the plateau's glaciers would likely be gone by 2050, and that well before then, a threshold will have been hit in which people who depend on the water will start to start to see supplies dwindle (Gardner, T, 2009, "Tibetan glacial shrink to cut water supply by 2050", *Reuters*, 17 January 2009). Without these glaciers, summer monthly water inputs in an average year would be down by 38% in the upper Indus basin, and by up to 58% in drought conditions. In addition, India's national water supply is forecast to fall 50% below demand as early as 2030, and increasing irregularities in the pattern of monsoon rains are likely to undermine South Asia's agricultural and domestic water needs. By 2022, India is projected to overtake China's population, becoming the most populous country in the world with 1.4 billion. This would continue to rise to 1.5 billion by 2030, and 1.7 billion by mid-century.

[37] Tropical Andes' glaciers have already lost on average 30–50 percent of their surface area and volume since the late 1970s, and may disappear within 40 years (Pappas, S, 2013, "Andes glaciers vanishing rapidly, study finds", *LiveScience*, 23 January 2013; Eleftheriou, K, 2015, "World's highest glaciers, in Peruvian Andes, may disappear within 40 years", *ABC News*, 6 November 2015),

[38] In his book *Six Degrees*, Mark Lynas reports that in a 3˚C-warmer world: "Although precipitation in the deep tropics is projected to increase, the subtropics get drier, and Central America is right in the middle of one of these drying zones. The Hadley centre model predicts rainfall declines of 1–2 mm per day, half of the total annual rainfall in some areas." Lynas says that, like during the Mayan collapse, lower rainfall means more intense droughts, worsening deforestation, and this is why Central America is identified as one of the world's climate hotpots.

[39] During the mid-Pliocene, when CO_2 levels were similar to today, there are also strong indications that permanent El Niño conditions prevailed. Hansen says

Aridification emerges over more than 30 percent of the world's land surface.[40] Desertification is severe in southern Africa[41], the southern Mediterranean[42], west Asia, the Middle East, inland Australia and across the south-western United States.[43]

Impacts: A number of ecosystems collapse, including coral reef systems, the Amazon rainforest and in the Arctic.[44]

Some poorer nations and regions, which lack capacity to provide artificially-cooled environments for their populations, become unviable.[45] Deadly heat conditions persist for more than 100 days per year in West Africa, tropical South America, the Middle East and South-East Asia,[46] which together with land

---

that rapid warming today is already heating up the western Pacific Ocean, a basis for a coming period of "super El Niños" (Hansen, J, et al, 2006, "Global temperature change", *Proceedings of the National Academy of Sciences*, 103, 14288-93).

[40] "Beyond 2050, as much as 44 percent of the planet's land areas will be exposed to drying. This will lead to severe drought conditions throughout southern Europe, North America (mainly the eastern and southwestern United States and Mexico), much of southeast Asia, and most of the Amazon—affecting about 1.4 billion people. In the latitude bands between 30 degrees N and 30 degrees S the probability of multi-decadal drought will rise to 80 percent" (Xu, Y, & Ramanathan, V, 2017, op. cit.).

[41] Thomas, D.S.G, et al., 2005, "Remobilization of southern African desert dune systems by twenty-first century global warming", *Nature* 435, 1218-21.

[42] Gibelin, A-L, and Déqué, M, 2003, "Anthropogenic climate change over the Mediterranean region simulated by a global variable resolution mode", *Climate Dynamics*, 20, 237-339. As one example, Christos Zerefos, head of the Research Center for Atmospheric Physics and Climatology at the Academy of Athens, says, "Around 30 percent of Greece could be threatened with desertification" (Elafros, Y, 2019, "Greece faced with threat of future desertification", *Ekathimerini*, 19 June 2019).

[43] Marvel, K, 2019, "Creeping toward permanent drought", *Scientific American*, 12 June 2019.

[44] See footnotes 22 and 25 above. Coral systems will be reduced to <10% at 1.5˚Cof warming (Frieler, K, et al., 2013, "Limiting global warming to 2˚C is unlikely to save most coral reefs", *Nature Climate Change,* 3, 165-170). By 2˚C, Australia's Great Barrier Reef could expect a significant bleaching event almost every year (King, A.D, et al., 2017, "Australian climate extremes at 1.5˚C and 2˚C of global warming", *Nature Climate Change,* 7, 412-416)

[45] Another and more stringent understanding of "lethal heat", different from Mora et al. described above, is one in which conditions are beyond the physiologic threshold for survival of healthy humans outdoors, which occurs when the Wet Bulb Temperature (WBT), a measure of both temperature and humidity, exceeds 35˚C for more than six hours, Under the IPCC high-emissions or business-as-usual (BAU) RCP8.5 scenario, warming by 2100 is in the range of 3–4˚C (technically, median of 3.7˚C and very likely between 2.6-4.8˚C), so high-emissions projections of deadly heat are relevant to our scenario. The fertile North China Plain is the heartland of modern China and has experienced a vast expansion of irrigated agriculture but, under a BAU scenario, the "North China Plain is likely to experience deadly heatwaves with WBT exceeding the threshold defining what Chinese farmers may tolerate while working out doors" (Kang, S. and Eltahir, E.A.B, 2018, "North China Plain threatened by deadly heatwaves due to climate change and irrigation", *Nature Communications*, 9, 2894). Another study found that under the BAU scenario, extremes of WBT in South Asia are likely to approach and, in a few locations, exceed the critical threshold, with the most extreme hazard from future heat waves concentrated around densely populated agricultural regions of the Ganges and Indus river basins. The authors say that "Climate change, without mitigation, presents a serious and unique risk in South Asia, a region inhabited by about one-fifth of the global human population, due to an unprecedented combination of severe natural hazard and acute vulnerability." (In, E.S, et al., 2017, "Deadly heat waves projected in the densely populated agricultural regions of South Asia", *Science Advances*, 3, e1603322). A third study found that extremes of WBT in the region around the Arabian Gulf are likely to approach and exceed the critical threshold under a BAU emissions scenario, particularly Abu Dhabi, Dubai, Doha and coastal cities in Iran. (Pal, J.S, and Eltahir, E.A.B, 2016, "Future temperature in southwest Asia projected to exceed a threshold for human adaptability", *Nature Climate Change,* 6, 128–129.). Jos Lelieveld, Director at the Max Planck Institute for Chemistry, says that If emissions continue to grow at the current rate, average temperatures in summer will rise by about 5 degrees Celsius in the Middle East and North Africa by mid-century (Hergersberg, P, 2016 "Hot Air in the Orient", Max Planck Research, 4-16, 62-68).The fatal 35˚C WBT level was almost reached in Bandar Mahshahr in Iran in July 2015, where 46˚C heat combined with 50% humidity, and this was at just 1˚C of global average warming.

[46] Under high-emissions scenarios, by 2100 (warming range around 3–4˚C), "mid-latitudes will be exposed to ~60 days per year [of deadly heat compared to almost the entire year in humid tropical areas" (Mora, C. et al., 2017, op cit.).

degradation and rising sea levels contributes to perhaps a billion people being displaced.[47]

Water availability decreases sharply in the most affected regions at lower latitudes (dry tropics and subtropics), affecting about two billion people worldwide.[48] Agriculture becomes nonviable in the dry subtropics.[49]

[47] How many people could be displaced internally and externally by all these processes? Nobody knows. The Syrian war, in part driven by climate factors — an epoch drought and a climate-driven spike in wheat prices/Arab Spring — led to the internal and external displacement of 11 million people in a population of 17 million. Virtually no-one saw this coming. The capacity to map physical climate changes onto social and political outcomes and people displacement on a global scale in a hotter world is poor. But here are some pointers:.

- In 2007 senior US national security analysts including, a former CIA director, concluded that: "Perhaps the most worrisome problems associated with rising temperatures and sea levels are from large-scale migrations of people — both inside nations and across existing national borders… potentially involving hundreds of millions of people. The more severe scenarios suggest the prospect *of perhaps billions of people over the medium or longer term* being forced to relocate. The possibility of such a significant portion of humanity on the move, forced to relocate, poses an enormous challenge even if played out over the course of decades." (emphasis added) (Campbell, K.M, et al., 2007, op cit.)
- The UN says that: "Unless we change the way we manage our land, in the next 30 years we may leave *a billion or more vulnerable poor people with little choice but to fight or flee*" (emphasis added) (UN Convention to Combat Desertification, n.d., "Sustainability. Stability. Security." www.unccd.int/sustainability-stability-security).
- As noted above, Xu and Ramanathan (2017) conclude "the likelihood of approximately half of the population exposed to deadly heat by 2050", "which could pose existential risks to humans and mammals alike unless adaptation measures are implemented, such as providing air conditioning to the entire population *or a massive relocation of most (sic!) of the population to safer climates*" (emphasis added) .
- The 2018 *Global Catastrophic Risks* report says that even for 2˚C of warming more than a billion people may need to be relocated (Wariaro, V, et al., 2018, *Global Catastrophic Risks 2018*, Global Challenges Foundation, Stockholm).
- The annual Global Peace Index estimated 971 million people live in areas with high or very high exposure to climate hazards including cyclones, floods, bushfires, desertification and rising sea levels. According to the Internal Displacement Monitoring Centre, more than 265 million people have been internally displaced by natural disasters since 2008 (Shelton, T, 2019, "Nearly a billion people facing high exposure to climate change effects, Global Peace Index finds", *ABC News*, 12 June 2019).

[48] Approximately 1.8 billion people around the world lack access to safe drinking water and nearly two billion people lack access to sanitation. According to the 2017 report, *Global Trends: Paradox of Progress* (US National Intelligence Council, Washington DC) "more than 30 countries — nearly half of them in the Middle East — will experience extremely high water stress by 2035, increasing economic, social, and political tensions". The CNA Military Advisory Board's 2014 report, *National Security Risks and the Accelerating Risks of Climate Change*, says that: "From today's baseline of 7.1 billion people, the world's population is expected to grow to more than 8 billion by 2025… by 2030, population growth and a burgeoning global middle class will result in a worldwide demand for 35% more food and 50% more energy. Rising temperatures across the middle-latitudes of the world will increase the demand for water and energy. These growing demands will stress resources, constrain development, and increase competition among agriculture, energy production, and human sustenance. In light of projected climate change, stresses on the water-food-energy nexus are a mounting security concern across a growing segment of the world." India's national water supply is forecast to fall 50% below demand as early as 2030, and increasing irregularities in the pattern of monsoon rains are likely to undermine South Asia's agricultural and domestic water needs (Ahmed, N.M, 2017, *Failing States, Collapsing Systems: Biophysical triggers of political violence*, Springer Briefs in Energy, Cham Switzerland). China contains 20% of global population but only 7% of available fresh water. 54% of the main rivers contain water unfit for human consumption (Cho, R, 2011, "How China is dealing with its water crisis", State of the Planet, *Columbia University Earth Institute News*, http://blogs.ei.columbia.edu/2011/05/05/how-china-is-dealing-with-its-water-crisis). A World Bank report on China's water situation foresees "catastrophic consequences for future generations" unless water use and supply can quickly be brought back into balance (Brown, L, 2013, "The real threat to our future is peak water", *The Guardian*, 6 July 2013).

[49] "Agriculture becomes nonviable in the dry subtropics, where irrigation becomes exceptionally difficult because of low water availability and increased soil salinization resulting from more rapid evaporation of water from irrigated fields. Arid regions at low latitudes expand, taking previously marginally

Most regions in the world see a significant drop in food production and increasing numbers of extreme weather events, including heat waves, floods and storms. Food production is inadequate to feed the global population and food prices skyrocket, as a consequence of a one-fifth decline in crop yields, a decline in the nutrition content of food crops, a catastrophic decline in insect populations, desertification, monsoon failure and chronic water shortages, and conditions too hot for human habitation in significant food-growing regions.[50]

The lower reaches of the agriculturally-important river deltas such as the Mekong, Ganges and Nile are inundated, and significant sectors of some of the world's most populous cities — including Chennai, Mumbai, Jakarta, Guangzhou, Tianjin, Hong Kong, Ho Chi Minh City, Shanghai, Lagos, Bangkok and Manila — are abandoned.[51] Some small islands become uninhabitable.[52] Ten percent of Bangladesh is inundated, displacing 15 million people.[53]

According to the Global Challenges Foundation's *Global Catastrophic Risks 2018* report, even for 2°C of warming, more than a billion people may need to be relocated due to sea-level rise, and In high-end scenarios "the scale of destruction is beyond our capacity to model, with a high likelihood of human civilisation coming to an end".[54]

---

productive croplands out of production" (Campbell, KM, et al., 2007, op cit.).

[50] "Heat and droughts threaten regions that produce much of the world's food. Food prices are expected to raise 23 percent by 2030, making food markets more volatile, and under heat stress the nutritious content of food crops is declining" (Ramanathan, V, et al., 2018 "Climate extremes and global health' , *Foreign Affairs*, 31 July 2018), "In the tropics and sub-tropics, geographic areas that include the world's hungriest people, climate change could cause crop yields to fall 10 to 20 percent or more between now and 2050" (Thornton, P, 2012, *Recalibrating food production in the developing world: global warming will change more than just the climate*, CCAFS Policy Brief 6, CGIAR Research Program on Climate Change, Agriculture and Food Security). "Under current production systems and practices, our models indicate aggregate crop yields [in the USA] could decrease during the end of the century (2050–2100) by 8%–19% under the mildest scenario (RCP 2.6), and by 20%–48% under the most severe scenario (RCP 8.5)." (Ortiz-Bobea, A, et al., 2019, "Unpacking the climatic drivers of US agricultural yields", *Environmental Research Lett*ers, 14, 064003) "Climate models project increased aridity in the 21st century over most of Africa, southern Europe and the Middle East, most of the Americas, Australia, and Southeast Asia" (Dai, A., 2010, "Drought under global warming: a review", *WIREs Climate Change*, 2, 45-65).

[51] "Chennai" should be "Kolkata". For "Manila" read "Miami". A 2011 study (Hanson, S, et al., 2011, "A global ranking of port cities with high exposure to climate extremes", *Climatic Change,* 104, 89–111) assessed the impacts of climate change on coastal cities on a 2070s timescale, with a global rise of 0.5 metre in sea level above current levels. The analysis considers a number of factors which could affect current and future exposure, including population and economic growth, natural subsidence/uplift, global sea-level rise and potential human-induced subsidence. Sea levels have already risen ~0.2 metre, so this is effectively a 0.7 metre study from a late 19th century baseline. The top 20 cities ranked in terms of population exposed to coastal flooding in the 2070s were:
Kolkata (Calcutta) 14,014,000
Mumbai (Bombay) 11,418,000
Dhaka 11,135,000
Guangzhou 10,333,000
Ho Chi Minh City 9,216,000
Shanghai 5,451,000
Bangkok 5,138,000
Rangoon 4,965,000
Miami 4,795,000
Hai Phòng 4,711,000
Alexandria 4,375,000
Tianjin 3,790,000
Khulna 3,641,000
Ningbo 3,305,000
Lagos 3,229,000
Abidjan 3,110,000
New York-Newark 2,931,000
Chittagong 2,866,000
Tokyo 2,521,000
Jakarta 2,248,000
See also: Holder, J, et al., (2017), "The three-degree world: the cities that will be drowned by global warming", *The Guardian*, 3 November 2017.

[52] Storlazzi, C.D, et al., 2018, "Most atolls will be uninhabitable by the mid-21st century because of sea-level rise exacerbating wave-driven flooding", *Science Advances*, 4, eaap9741.

[53] A one-metre sea level rise would flood 20% of the area of Bangladesh and displace 30 million people, according to Maj. Gen. Munir Muniruzzaman, former military adviser to the president of Bangladesh and chairman of the Global Military Advisory Council on Climate Change (Daily Mail, 2016, "Military experts warn of "epic' humanitarian crisis sparked by climate change", *Daily Mail*, 1 December 2016).

[54] Wariaro, V, et al., 2018, op cit.

National security consequences: For pragmatic reasons associated with providing only a sketch of this scenario, we take the conclusion of the *Age of Consequences* "Severe' 3˚C scenario[55] developed by a group of senior US national-security figures in 2007 as appropriate for our scenario too:

> "Massive nonlinear events in the global environment give rise to *massive nonlinear societal events*. In this scenario, nations around the world will be *overwhelmed by the scale of change* and pernicious challenges, such as pandemic disease. The internal cohesion of nations will be under great stress, including in the United States, both as a result of a dramatic rise in migration and changes in agricultural patterns and water availability. The flooding of coastal communities around the world, especially in the Netherlands, the United States, South Asia, and China, has the potential to *challenge regional and even national identities*. Armed conflict between nations over resources, such as the Nile and its tributaries, is likely and nuclear war is possible. The social consequences range from increased religious fervor to *outright chaos*. In this scenario, climate change provokes *a permanent shift in the relationship of humankind to nature*' (emphasis added)."

[55] Campbell, K.M, et al. 2007, op cit.

THE AGE OF CONSEQUENCES FULL 3ºC SCENARIO

BACKGROUND

*In 2007 the Centre for Strategic and International Studies and the Centre for New American Security published "*The Age of Consequences: The foreign policy and national security implications of global climate change"*. Its eleven authors included R. James Woolsey, a former director of the CIA, John Podesta, former chief of staff to Bill Clinton, and a range of physical and social scientists and national security analysts. At the heart of the study were three plausible scenarios of future climate change, and their national security consequences. The middle of the three scenarios was entitled "Severe climate change over the next 30 years", and laid out a scenario in which warming had reached 2.6˚C above 1990 levels (just over 3˚C compared to the late 19th century) and a 0.52 metre sea level rise. Here we reproduce that scenario from the report. It is a chilling assessment and adds to the picture of what the world could look like at 3˚C of warming.*

SCENARIO: CLIMATE CHANGE OVER THE NEXT 30 YEARS

At a glance:

Time span: 30 Years
Warming 2.6˚C (over 1990 levels)
Sea Level rise: 0.52 metres

SCENARIO OVERVIEW: SEVERE CLIMATE CHANGE

The projection of severe climate change employed in this chapter is based on IPCC findings, with an adjustment to account for possible "tipping point" events such as the abrupt release of massive quantities of methane from melting tundra or of carbon dioxide as the sea warms up. Under these conditions, adverse trends could accelerate abruptly:

- Over the next 30 years, average global surface temperature rises unexpectedly to 2.6˚C above 1990 levels, with larger warming over land and sheets accelerate rapidly, resulting in 52 centimeters of sea level rise. Based on these observations and improved understanding of ice sheet dynamics, climate scientists by this time express high confidence that the Greenland and West Antarctic Ice Sheets have been destabilized and that 4 to 6 meters of sea level rise are now

inevitable over the next few centuries, bringing intense international focus to this problem.

- Water availability decreases strongly in the most affected regions at lower latitudes (dry tropics and subtropics), affecting 1 to 2 billion people worldwide. The North Atlantic overturning circulation slows significantly, with consequences for marine ecosystem productivity and fisheries.
- Crop yields decline significantly in the fertile river deltas because of sea level rise and damage from increased storm surges. Agriculture becomes essentially nonviable in the dry subtropics, where irrigation becomes exceptionally difficult because of dwindling water supplies, and soil salinization is exacerbated by more rapid evaporation of water from irrigated fields. Arid regions in the low latitudes have spread significantly by desertification, taking previously marginally productive crop lands out of production.
- Global fisheries are affected by widespread coral bleaching, ocean acidification, substantial loss of coastal nursery wetlands, and warming and drying of tributaries that serve as breeding grounds for anadromous fish.
- The Arctic Ocean is now navigable for much of the year because of decreased Arctic sea ice and the Arctic marine ecosystem is dramatically altered. Developing nations at lower latitudes are impacted most severely because of climate sensitivity and high vulnerability. Industrialized nations to the north experience net harm from warming and must expend greater proportions of GDP adapting to climate change at home.

This projection serves as the basis for a scenario depicting the possible societal consequences of severe climate change over the course of thirty years. These consequences are not to be taken as predictions: they represent a selected construct of the future, intended to encourage reflection about the consequences of continued inaction.

The Role of Complexity

Climate change is a manifestation of phenomena that are complex in the technical sense of that word. Complex phenomena are nonlinear and unstable, "Nonlinear" means that incremental change in the level of inputs to a system can result in major, and even discontinuous changes in the system's output, "Unstable" means that it is not possible to create a single, normative model for the system's behavior: instead, modeling must assume the possibility of surprise. It is readily seen that even incremental levels of climate change will have political consequences, but a less obvious, and major, premise of this chapter is that *nonlinear climate change will produce nonlinear political events*.

If the environment deteriorates beyond some critical point, natural systems that are adapted to it will break down. This applies also to social organization. Beyond a certain level climate change becomes a profound challenge to the foundations of the global industrial civilization that is the markof our species.

REGIONAL SENSITIVITY TO SEVERE CLIMATE CHANGE

According to the IPCC findings the poorest nations will suffer first and also most deeply from climate change. Despite this, my analysis of the international consequences of climate change begins with the wealthiest and strongest societies since it is their responses that will make the difference between relative order and freefall.

United States

Even at lesser degrees of climate change we should expect more severe weather along our coasts, with increasingly violent storms coming in from the sea at much higher rates of incidence. Very early on in this process important social readjustments will occur—if only because of measures that the insurance and mortgage industries will take in their own defense. This is already visible along the Gulf Coast in Hurricane Katrina's aftermath.

Even at linear rates of sea level rise, such as those forecast at the lower range of the scenario, exponentially greater numbers of people would be affected. One storm model concludes that what is now a 100-year flooding event in New York City will be a 4-year event with an additional meter of sea level.[56] Early on, there will be talk of massive engineering efforts to protect major economic centers along the coasts, including oil and gas production in the Gulf.

In our scenario, however, estimates of conditions abruptly become worse as science adjusts for new theory and new data. Given this deteriorating prospect for the future, the idea of resisting nature by brute engineering will give way to strategic withdrawal,

[56] C. Rosenzweig, C, 2004, "Using Regional Models to Assess the Potential for Extreme Climate Change," Columbia University Center for Climate Systems Research.

combined with a rear guard action to protect the most valuable of our assets. Optimists might hope for a gradual relocation of investment and settlement from increasingly vulnerable coastal areas. After a certain point, however, sudden depopulation may occur.

Severe climate change will attack the West Coast's economic foundations because of drastic, permanent water shortage — resulting not only from reduced annual rainfall, but also from the disappearance of mountain snow, whose spring melt-off is vital to the entire region's hydrology. The water requirements of the great West Coast cities are already in conflict with the region's requirements for agriculture. In the more destructive ranges of the severe scenario, it would no longer be possible to bridge this conflict through political compromise or adroit water management. Political tensions would be severe. Moreover, the damage to American agriculture will not be limited to California. There will be intensified dependence on irrigated farming in the Midwest, and this will result in the accelerated depletion of the Ogallala aquifer, upon which the entire region's agrarian economies depend.[57]

The United States' federal system may also experience stress. As noted above, one possible consequence of severe climate change will be greatly increased frequency of region-wide disasters as the result of an increasing number of especially violent storms. At some level, even a well-prepared Federal Emergency Management Agency (FEMA) system might be overwhelmed. As the cumulative magnitude of such damage increases, the federal government would likely leave state governments to shoulder more and more of the burden. The effect would be to strain the ligaments that hold the federal system together.

State governments are already pulling away from federal leadership on the environment. California is the leading example but others are coming along, mainly in the form of regional groupings.[58] The federal government is already fiscally compromised by defense costs in competition with escalating costs for maintaining the social contract. The additional costs entailed by climate change will make these problems unmanageable without drastic tradeoffs. At some point the government's ability to plan and act proactively will break down because the scale of events begins to overwhelm policies before they can generate appreciable results.

Western Hemisphere

Accumulated stresses owing to severe climate change may cause systemic economic and political collapse in Central and Latin America. The collapse of river systems in the western United States, for example, will also have a devastating effect on northern Mexico.[59] In Mexico, climate change likely means mass migration from central lowlands to higher ground. Immigration from Guatemala and Honduras into southern Mexico (whether for employment in Mexico, or passage to the United States) is already a major issue for the Mexican government, and will intensify dramatically. The pass-through consequence for the United States is that border problems will expand beyond the possibility of control, except by drastic methods and perhaps not even then. Efforts to choke off illegal immigration will have increasingly divisive repercussions on the domestic social and political structure of the United States.

Severe climate change will likely be the deathblow for democratic government throughout Latin America, as impoverishment spirals downward. In these circumstances we should expect that populist, Chavez-like governments will proliferate. Some regions will fall entirely and overtly under the control of drug cartels. Some governments will exist only nominally, and large regions will be essentially lawless, much as has been the case in Colombia. The United States will lack adequate means for responding effectively, and will likely fall back on a combination of policies that add up to quarantine.

Tensions will increase between the United States and Canada, including clashes over fishing rights on both coasts. Two-thirds of Canadians rely on the Great Lakes (a relatively small watershed).

Water levels are projected to decline by up to one foot in this century, attributable to increased evaporation, coupled with population growth. If the United States decides to divert water from the Great Lakes to compensate for the effects of climate change, the makings are in place for a fundamental clash of interests with Canada. There will also be an entirely new set of problems relating to navigation and

[57] "Ogallala Aquifer," Encyclopedia of Water Resources, at http://www.waterencyclopedia.com/Oc-Po/Ogallala-Aquifer.html.

[58] Marris, E, 2007, "Western States Reach Carbon Scheme," *Nature,* 446, 114–115.

[59] Opie, J, 1993, Ogallala: Water for a Dry Land, Lincoln: University of Nebraska Press,

resource rights, as the result of the opening of a northwest passage. It cannot be excluded that Canada's tensions with the United States will play into domestic issues affecting the stability of Canada itself: most notably, the western provinces' new role as oil exporter.

The cumulative effect of all these and related factors will be to render the United States profoundly isolated in the Western Hemisphere: blamed as a prime mover of global disaster; hated for measures it takes in self-protection.

Europe/Eurasia

The prospect of a new ice age in Europe caused by the Gulf Stream's collapse is not an element of the severe climate scenario that serves as the basis for this chapter. But there is enough bad news for Europe in the scenario as it stands. Severe climate change will threaten every major port city in Europe (the UK included). This will translate into huge economic costs at the national level, and prompt demands for EU intervention that are likely to exceed both its economic and its political resources. The Netherlands will be a particularly wrenching problem: a society at the core of European culture, which physically exists by restraining the sea, will be threatened by inundation. How will Europe share the costs of redesigning an entire nation?

Environmental pressures will accentuate the migration of peoples to levels that effectively change the ethnic signatures of major states and regions. In Europe the influx of illegal immigrants from Northern Africa and other parts of the continent will accelerate and become impossible to stop, except by means approximating blockade. There will be political tipping points marked by the collapse of liberal concepts of openness, in the face of public demands for action to stem the tide. As the pressure increases, efforts to integrate Muslim communities into the European mainstream will collapse and extreme division will become the norm.

The beginnings of these trends are present now. But severe climate change will cause them to become far worse. One of the casualties of this process may be any prospect for the cultural, much less the political integration of Turkey into the EU. Even if Turkey were to be admitted, the increasing reaction of Europeans against Islam may alienate the Turkish people, thereby destroying the hoped-for role of Turkey as a bulwark against radical Islam. At severe levels of climate change, civil disorder may lead to the suspension of normal legal procedures and rights. The precedents for dealing with large, unwanted minorities have already been set in Eurasia under fascism and communism. Under conditions marked by high levels of civil confusion and fear, political leaders and movements will emerge who might not resist these solutions.

In parts of the Russian Federation the Slavic population will continue receding while immigration from Asia intensifies. At some point these tensions may accumulate to the point where Moscow and Beijing collide over matters each believes to be vital to its own political stability and to the survival of its regime. Growing Asian settlement in portions of the Russian Federation will also result in increased friction, specifically with Russia's rapidly growing Islamic population.

The Russian core of the Federation will certainly not respond to these developments by shifting to liberal democracy. On the contrary, the antidemocratic legacy of the Putin period will be reinforced. Russia will return to its roots—to a czarist-like system in all but name, with the wealth of the country divided among a new "boyar" class as payment for loyalty. This regime will anchor itself ideologically in Russian nationalism, and economically on the basis of a dominant energy position, which it will exploit aggressively. These trends are established already. Severe climate change will intensify them under Putin's successors.

Rising sea levels and accentuated storm systems will threaten China's industrialized coastal regions. Chinese economic growth will suffer as a result of the accelerated loss of land fertility due to salinization of river deltas, compounding shortages of arable land lost to urbanization. Decreased rainfall will accelerate China's already critical shortage of water, not only for drinking but also for industrial purposes. This will also cancel out the promised effects of massive hydro-engineering projects such as the Three Gorges Dam. There will be significant environmental pressures arguing for an inland shift of economic activity. China might be better able than other societies to accomplish this kind of transition, but the western reaches of China are water and resource poor. China will also find itself in direct confrontation with Japan and even the United States over access to fish, at a time when all major fisheries will likely have crashed as the result of today's unsustainable fishing practices, combined with the ongoing, worldwide decimation of wetlands.

All this can place tremendous additional pressure on the national concept and on the Chinese political system. That system is already under stress; witness tens of thousands of clashes each year between the populace and local authorities. Political reform and liberalization of government control may be the necessary response to this kind of discontent, but severe climate change is much as well as the provincial governments, in the opposite direction.

Indian Subcontinent

On the Indian subcontinent the impact of global warming will be very destabilizing. As glaciers melt the regions bounding the Indus and Ganges Rivers will experience severe flooding. Once the ice-packs are gone the floods will be replaced by profound and protracted drought. The inland backflow of salt caused by higher sea levels, will contaminate low-lying, fertile delta regions. Bangladesh, already famously vulnerable to storm surges, will become more so as sea levels rise.

Given the subcontinent's size and the variety of its regions, it is not possible to confidently interpolate from the IPCC's very broad findings down to the specifics needed for detailed political and security analysis. It is reasonable to say, however, that new and intense environmental pressures will be bad for the internal stability of each country on the subcontinent, and bad for their relations with each other. At severe levels of climate change, the survival of Indian democracy will be at risk.

The Indus River system is the largest contiguous irrigation system on Earth with a total area of 20 million hectares and an annual irrigation capacity of more than 12 million hectares. The headwater of the basin is in India; thus India is the most powerful player.[60] Currently, Pakistan, Bangladesh, and Nepal are engaged in water disputes with India.

The Indus Water Treaty of 1960 settled some overarching issues, but frequent disagreements persist. (Pakistan now considers India in breach of the treaty for having caused "man-made river obstructions.")[61] Climate change will exacerbate these tensions. Because of India's clear upper hand, Pakistan may resort to desperate measures in seeking water security.

[60] Bajpaee, C, 2006, "Asia's Coming Water Wars," *Power and Interest News Report*, 22 August 2006.
[61] Ibid.

North Africa and the Middle East

The northern tier of African countries will face collapse as water problems become unmanageable, particularly in combination with continued population growth. Morocco may be destabilized as a result of drought-induced failure of that country's hydroelectric power system and its irrigation-based agriculture. Those countries that can afford it may follow Libya's lead and attempt to tap major aquifers in a zero-sum struggle for survival. Muammar al-Qaddafi's $20 billion mass-irrigation project would drain much of Great Nubian Sandstone Aquifer (nearly the size of Germany) in 50 years.

Newly oil-rich Sudan is seeking to irrigate some of the Sahel; Ethiopia has claimed that any Sudanese effort to divert water from the Nile would provoke military response. Egypt will clash with Sudan and/or Ethiopia over any effort by either to manipulate the flow of waters tributary to the Nile.

Efforts to design a solution to the Israeli-Palestinian struggle will be abandoned for the indefinite future because of a collective conclusion that the problem of sharing water supplies must be regarded as permanently intractable. War between Israel and Jordan over access to water is conceivable.

Moreover, Iraq, Syria, and Turkey are likely to be enmeshed in an escalating struggle over the latter's command of waters feeding the Tigris/Euphrates systems. In the Gulf countries there will be a rapid expansion of nuclear power for desalinization. This will, in turn, become a contributing factor in the regional proliferation of nuclear weapons as insurance against predation.

Rising sea levels will cause extensive damage to delta regions (normally among the most fertile and heavily settled) as sea water presses further upstream. This is already a problem in the Nile Delta, where the accelerated loss of fertile land will compound the impact of Egypt's oncoming demographic "youth bulge."

Sub-Sahara and the Horn of Africa

In sub-Saharan Africa, hundreds of millions of already vulnerable persons will be exposed to intensified threat of death by disease, malnutrition, and strife. Natural causes such as long-term drought will play a major role, but political factors will either make these disasters much worse, or even precipitate them as the result of a mix of mismanagement and miscalculated policy. Such was the case in Ethiopia during the rule of

Col. Mengistu Haile Mariam. The ongoing genocide in Darfur may have begun as a consequence of water scarcity, as noted elsewhere in this report.

Under conditions of severe global climate change environmental factors will push already failed states deeper into the abyss, while driving other states toward the brink. The stronger regional states, such as South Africa, will be affected not only by internal social and economic stress related to changing climatic patterns, but also by southward flows of refugees hoping for rescue and safety.

Contemporary Africa aspires to be a unified system but falls far short. Severe climate change would, in a grim way, provide for the first time the missing element of connectivity. From one end of the African continent to the other, severe climate change will become the common denominator of turbulence and destruction.

SYSTEMIC EVENTS

As noted above, this chapter's analytic premise is that massive nonlinear events in the global environment will give rise to massive nonlinear societal events. The specific profile of these events will vary, but very high intensity will be the norm.

- We could see class warfare as the wealthiest members of every society pull away from the rest of the population, undermining the morale and viability of democratic governance, worldwide.
- It is possible that global fish stocks will crash. Signs are that this process is already well established and accelerating. Aquaculture will expand dramatically to mitigate fish protein shortages, but the destruction of natural marine food chains will have an incalculable impact on the viability of the oceans themselves.
- Climate change may have serious impacts on disease vectors. Under conditions of extreme climate change the risk of pandemic explosions of disease increase.
- As drinkable water becomes scarcer it will become an increasingly commercialized resource. Governments, lacking the necessary resources, will privatize supply. Experience with privatized water supply in poor societies suggests the likelihood of violent protest and political upheaval.
- Human fertility may collapse in economically advanced regions, as the consequence of increasingly difficult living conditions and of general loss of hope for the longer term.
- Globalization may end and rapid economic decline may begin, owing to the collapse of financial and production systems that depend on integrated worldwide systems.
- Corporations may become increasingly powerful relative to governments as the rich look to private services. This may engender a new form of globalization in which transnational business becomes more powerful than states.
- Alliance systems and multilateral institutions may collapse—among them the UN, as the Security Council fractures beyond compromise or repair.

Moral Consequences

Massive social upheaval will be accompanied by intense religious and ideological turmoil, as people search for relief and hope. For this purpose, it is fair to consider that certain kinds of political doctrine may be thought of as religious. Fascism and communism certainly filled that role for true believers during the 20th century. Among traditional religious beliefs, the "losers" are likely to be those faiths that have formed the closest associations with the secular world and with scientific rationalism. Among political systems, authoritarian ideologies would certainly be the "winners." One way or the other, severe climate change will weaken the capacity of liberal democratic systems to maintain public confidence.

This intensified search for spiritual meaning will be all the more poignant under conditions of severe climate change. Governments with resources will be forced to engage in long, nightmarish episodes of triage: deciding what and who can be salvaged from engulfment by a disordered environment. The choices will need to be made primarily among the poorest, not just abroad but at home. We have already previewed the images, in the course of the organizational and spiritual unraveling that was Hurricane Katrina. At progressively more extreme levels, the decisions will be increasingly harsh: morally agonizing to those who must make and execute them—but in the end, morally deadening. For comparison one might look to estimates of the effects of a new global pandemic carried by avian flu.

Die-off

War and disease can be the means to achieve a grim kind of environmentally sustainable relationship between humankind and nature. Hundreds of millions of people already survive on a hand-to-mouth basis, living essentially on the leavings and limited charity of

those who are better off. As climate change deepens, even the "donor" portion of society will feel the effects, and those below will be much worse off than before.

Severe climate change will put additional stress on all systems of social support. Already tenuous health care systems may collapse. Vulnerability to new forms of disease will increase. In some regions the process may resemble the abrupt dieoffs that are thought to have occurred on a smaller scale among ancient peoples. Instead of focusing on ways to save modern civilization, social survival.

Preemptive desertion of urban civilization will occur. Attention to the long-term requirements of society will attrite, in view of a public conviction that nothing can be done to alter the downward course of events.

Survival and Reconstruction

The consequences of even relatively low-end global climate change include the loosening and disruption of societal networks. At higher ranges of the spectrum, chaos awaits. The question is whether a threat of this magnitude will dishearten humankind, or cause it to rally in a tremendous, generational struggle for survival and reconstruction.

If that rally does not occur relatively early on, then chances increase that the world will be committed irrevocably to severe and permanent global climate change at profoundly disruptive levels. An effective response to the challenge of global warming cannot be spread out across the next century, but rather must be set in place in the next decade, in order to have any chance to meaningfully alter the slope of the curves one sees in the IPCC report. We are already in the midst of choosing among alternative futures. The onset of these choices is rapid, and the consequences are likely to be irreversible.

Moreover, the upper end of the "severe, 30-year scenario" can just as well be a prelude to even worse circumstances, if the political will to deal with global warming collapses early on under the weight of universal pessimism.

In order to emerge from a period of severe climate change as a civilization with hopes for a better future and with prospects for further human development, the very model of what constitutes happiness must change. Globalization will have to be redirected. It cannot continue forever in its present form, based on an insatiable consumption of resources. The combined demands of China and India alone cannot be satisfied in a world already heavily burdened by the consumption patterns of the United States, Europe, and Japan.

Levels of demand will have to be brought into line with the availability of resources. This can occur either as the result of the collapse of the present system, or by its purposeful reconfiguration. The promise that it is possible to achieve high levels of consumption for all people everywhere would be unable to be fulfilled. The ideal of international development would be seen to have failed, with profound political consequences. Neither China nor India can voluntarily accept that their hopes for full-fledged consumer societies cannot be realized.

Conclusion

As discussed above, the reduction of humankind's burden on the environment can occur as the result of deteriorating physical conditions and attendant pandemics. It can also occur as the result of war and its aftermath. Under the circumstances described above, it is clear that even nuclear war cannot be excluded as a political consequence of global warming. Moreover, so-called "limited nuclear war" in any part of the world can escalate to a full-scale nuclear exchange among the nuclear powers. Even if one assumes that there will be very large reductions of nuclear weapons in the inventories of the United States and the Russian Federation, it should be kept in mind that the weapons on board a single submarine armed with ballistic missiles are fully capable of destroying a nation of continental size.

The alternative to reducing populations by decimation is to reduce them by demographic management. Every nation has a demographic curve, showing the rate at which the size and composition of its population will change over time, given certain assumptions. Today, advanced states use macroeconomic techniques to manage their economies: tomorrow, such states may be looking for macro-techniques to manage reproductive choice against basic targets. This is a radical departure, given the way people everywhere feel about reproductive freedom. But if the alternative is truly ruinous, what is presently unthinkable may wind up on the table. China will be an early bellwether.

Climate change represents a permanent shift in the relationship of humankind to nature. Since we already have attained the power to alter natural cycles we are now accountable for regulating our impact upon them. To fulfill this stewardship responsibly we must

improve the capacity of governance to deal with all kinds of complex phenomena: through earlier recognition and response to important challenges; deeper awareness of interactions across substantive and bureaucratic boundaries; and the ability to organize and execute policy for operation over extended periods of time.

Finding and applying the necessary political and governmental innovations is daunting, but it is a task within our capabilities, as has been repeatedly demonstrated in the course of our history.

CONCLUSION

The value of intelligent, comprehensive scenario planning can be seen in *The Age of Consequences* scenario and its willingness to "think the unthinkable". It is prescient in foreseeing circumstances that are now arising, including:

- "Border problems will expand beyond the possibility of control, except by drastic methods and perhaps not even then. Efforts to choke off illegal immigration will have *increasingly divisive repercussions on the domestic social and political structure of the United States*" (emphasis added);
- The cumulative effect of climate impacts "will be to render the United States *profoundly isolated in the Western Hemisphere*: blamed as a prime mover of global disaster; hated for measures it takes in self- protection" (emphasis added);
- "In Europe the influx of illegal immigrants from Northern Africa and other parts of the continent will accelerate and become impossible to stop, except by means approximating blockade. There will be political tipping points marked by the collapse of liberal concepts of openness, in the face of public demands for action to stem the tide. As the pressure increases, efforts to integrate Muslim communities into the European mainstream will collapse and extreme division will become the norm."

These are the tip of the iceberg, with warming now just nudging past 1˚C, compared to these scenarios which paint a feasible and much broader picture of a world 3˚C warmer.

Understanding what 3˚C of warming really means should be a great motivator for climate emergency action.

We have been warned that massive non-linear physical climate warming events will give rise to massive non-linear social events.

What will these "surprises" look like for Australia and its regions? We need to know, but we don't because this quality of scenario planning has not been done for Australia. This is the direct result of the dominant group-think of climate delay and denial which has characterised most of our political and corporate elites over the last three decades, preventing the development of sensible climate policy.

If anything, the political denial is hardening, even as the physical impacts of climate change and its economic costs mount. The fact that realistic alternative energy and other solutions are economically undercutting the traditional fossil fuels, even gas, which are enshrined in our high-carbon denialist Official Future, is testimony to the ideological myopia.

The first priority of any government is to protect its people. Climate change now represents the greatest threat to that security, far outweighing conventional geopolitical threats such as any US-China or Middle East confrontation.

Likewise, company boards have a fiduciary responsibility to ensure the viability of their organisations, and manage the threats they face, in the interests of shareholders, customers and community. Climate change is now the greatest threat to that viability, far greater than the 2008 Global Financial Crisis, as regulators around the world are now emphasising.

At present, because of the complacent group-think of our leaders, the Australian community is totally unprepared for the climate impacts which are already causing havoc across the continent, and which will escalate. This threat is not new, having been foreshadowed by the scientific community for decades.

The current Official Future is nothing less than criminal negligence by the political and corporate incumbency.

Holistic scenario planning on the real implications of climate change for Australia, encompassing the full range of possible futures, must be initiated as a matter of extreme urgency. We must rapidly rethink our Official Future before events move beyond our ability to influence outcomes. That must be done at the national level, and embraced with an all-encompassing commitment from politics, business and the community.

To gain community support for the massive economic and social changes ahead, the outcomes of such analysis must become normalised in our thinking, socialised in everyday discussion, and become the basis for planning and action.

It must be done openly, using the best expertise, without political or corporate interference sweeping inconvenient truths under the carpet, as has happened so often in the past. From now on policy must protect the future from the past, not the past from the future.

> *"Men and nations do behave wisely, once they have exhausted all other alternatives."*[62]

Having exhausted the denialist Official Future, now is the time for our new Parliament, and corporate leaders, to change direction and demonstrate they have the wisdom and leadership the Australian community deserves.

[62] Israeli foreign minister Abba Eban in 1975: https://quoteinvestigator.com/2012/11/11/exhaust-alternatives/


BREAK
THROUGH