IN THE WAITANGI TRIBUNAL

WAI 3325
WAI 3262

IN THE MATTER OF	the Treaty of Waitangi Act 1975
AND	
IN THE MATTER OF	the Climate Change Priority Inquiry (Wai 3325)
AND	
IN THE MATTER OF	a claim by Emily Tuhi-Ao Bailey on behalf of herself and Climate Justice Taranaki

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STATEMENT OF EVIDENCE OF ILAN NOY
Dated: 6 May 2025

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INTRODUCTION

1. My name is Ilan Noy. I am the Te Āwhionukurangi – the Chair in the Economics of Disasters and Climate Change and Professor of Economics at Te Herenga Waka – Victoria University of Wellington.

2. I have been doing research on extreme weather events and climate change impacts and adaptation for the past 18 years and have published more than 100 papers and reports about this topic. I attach my Curriculum vitae to my statement of evidence as **Appendix A**.

3. I have been assisted in the preparation of this evidence by Tomáš Uher. Tom is a researcher at Te Herenga Waka - Victoria University of Wellington and holds a master's degree from the Czech University of Life Sciences in Prague.

4. I have been asked to provide this statement by Climate Justice Taranaki.

5. I have read the Code of Conduct for Expert Witnesses at Schedule 4 of the High Court Rules 2016 and while the Tribunal is not a Court, I confirm that I agree to comply with the it. I understand and accept that it is my overriding duty in this proceeding to assist the Tribunal in matters that are within my expertise, and I confirm that the opinions I provide are within my expertise and experience.

Methods of climate change economic evaluation

6. Economic impacts of climate change are quantified using various methods. For assessments of total economic impacts, the two main approaches are Integrated Assessment Models (IAMs) and econometric analyses. Additionally, extreme event impact attribution (EEIA) can be used to assess climate change costs related to extreme weather events, as these costs are typically overlooked by the two main approaches.

7. IAMs combine knowledge from various disciplines, including climate modelling, land-use modelling, modelling of the energy sector, and macro-economic modelling, to study the relationships between the natural and human components of the earth system and project how the system may evolve over time (Parson and Fisher-Vanden, 1997). The models estimate

future atmospheric composition and temperature changes based on a set of assumptions about population growth, economic growth, climate mitigation policies and other factors. These models then apply damage functions to quantify the resulting economic costs of climate change and how these feed back into the earth system. IAMs are frequently used for assessing options to address climate change and play an important role in climate policy analyses and international climate agreements. They are prominent in the IPCC's Working Group III work on the mitigation of greenhouse gasses.

8. An alternative to IAMs is a set of statistical-econometric approaches which empirically link past changes in temperature to the level or growth of economic output and similar measures of economic activity (Chang et al., 2023). These methods assume that climate differences between locations, and within locations over the past few decades, can be used as analogues to how the climate will impact the economies of the future. These methods include Ricardian approaches that are based on long-run variations in climate; and approaches that are based on short-term variations in the weather; and approaches that combine the two. These econometric approaches generally predict the lowest climate change costs relative to other approaches, though both approaches vary a lot in their estimates of the economic costs of climate change (Tol, 2024). As a rule for both approaches, more recent estimates tend to be more comprehensive and account for more channels of impacts, and these produce significantly larger aggregate estimates of the costs of climate change.

9. EEIA methods represent an alternative way to quantify climate change costs, focusing solely on extreme events. These methods attempt to quantify the extent to which anthropogenic climate change influenced the impacts of specific weather events, focusing mostly on heatwaves, droughts, flood, and tropical cyclones (hurricanes). They build on the methods of extreme event attribution which quantify to what extent climate change made an event more likely and/or more intense. This is combined with the information on events impacts to determine the fraction of the event's impacts that is attributable to climate change (Noy et al., 2024). By aggregating these costs for extreme weather events globally, and comparing these to some of the leading IAMs, Newman and Noy (2023) conclude that the IAMs dramatically under-estimate the specific climate change costs that are associated with extreme weather. EEIA, however, cannot account for other climate change costs, such as those

resulting from more gradual processes like sea level rise or from ecosystem changes (for example, from the distribution of new pests).

Underestimation of climate change costs in Aotearoa New Zealand

10. The older existing estimates of the economic impacts of climate change for Aotearoa New Zealand (NZ) generally suggest relatively moderate impacts, less severe than for more vulnerable countries – especially those located closer to the equator or those that have large populations living in flood plains. The estimates provided in some of the global climate change economic impact assessments, and applied to the NZ context, vary in their severity. For example, Burke et al. (2015) predict low impacts for NZ, but some of the more recent assessments updating the Burke et al estimates, such as Kahn et al. (2021), Kotz et al. (2024) and Neal et al. (2025) predict much more pronounced impacts for the country.

11. The methods which are currently used to assess economic impacts of climate change are inadequate to produce reliable results for a country with an atypical economic composition such as NZ, with its heavy reliance on tourism and agriculture (very atypical for a high-income country). This inability to reliably estimate the costs arise because many of the complex and sector-specific risks linked to climate change are poorly understood, are deeply uncertain, and are too difficult to model in the NZ sectoral context. As a result, they are excluded from economic evaluations (Rising et al., 2022a). Because of our limited knowledge, the current evaluations are based on erroneously simplifying assumptions and exclude consequential interlinkages between the natural and human systems, climate tipping points (such as ice sheet collapses), and indirect and cascading effects (Keppo et al., 2021; Rising et al., 2022b; Weyant, 2017). This suggests that there is significant probability that the current estimates of the economic costs of climate change, based on the best available science, represent an underestimation, and possibly even a severe underestimation (Keen et al., 2021).

12. For example, the IAMs do not account for a multitude of indirect and non-linear effects. These effects include the roles of several climate-change-related phenomena in shaping economic potential. These climate-change-related phenomena include biodiversity loss, ocean acidification, domestic geopolitical tensions and external geostrategic threats that are created by the

changing circumstances, migration pressures (migration is an important adaptation tool), trade wars arising from the changing climatic condition for agricultural production, global supply chain and commodity markets disruptions, and many other potential channels. In addition, IAMs do not account for the possibility of catastrophic outcomes such as ecosystem or societal collapses. These collapses can directly occur in Aotearoa New Zealand or happen elsewhere and consequently impact NZ (for example, through large numbers of people seeking refuge).

13. Econometric methods are similarly limited in their scope. Most econometric methods assume that economies are only affected by the domestic weather (and sometimes only the average weather, and not its distribution over the year/quarter/month. These methods do not account for the interconnectedness of the global economy. Economic outcomes are clearly influenced also by conditions in other parts of the world, since international trade flows and supply chains are important everywhere. A recent attempt to include global weather conditions in the econometric models found that this led to a significant increase in damage estimates from ~11% to ~40% of global GDP in 2100 (Neal et al., 2025). But even for these assessments that include the global weather, various simplifying assumptions are required, even though these assumptions are unlikely to be true. For example, they assume that temporal variability in the weather is analogous to geographic variability, implying that differences across locations are consistent over time. It is also assumed that the existing relationship between temperature and GDP can be used as a reliable proxy for the impact of future warming (Diesendorf et al., 2024). Importantly, these assessments also leave out considerations about the unequal distribution of impacts, and the relative importance places on impacts in diverse communities[1] (Weyant, 2017; Emmerling and Tavoni, 2021).

14. Economic assessments also largely exclude the impacts of extreme weather events. Excluding the consideration of extreme weather events in assessments of overall costs is consequential, as the influence of climate change on the probability and intensity of extreme weather events is possibly

[1] Intergenerational equity is an important consideration within the Rauora Indigenous Worldview, a framework which has been explored by the Ministry for the Environment to guide its approach for the National Climate Change Adaptation Plan (Ihirangi, 2021).

among the most important climate change effects in NZ. Notably, the 2023 Auckland Anniversary floods and Cyclone Gabrielle were by far the costliest weather disasters in NZ's history (ICNZ, n.d.) and were made more severe by anthropogenic climate change (Harrington, et al. (2023). Thus, the inclusion of the contribution of climate change to extreme weather and its impacts in Aotearoa New Zealand would likely lead to much higher climate change cost estimates.

15. Another important distinction that is relevant for the cost assessment in this context is the significant difference in views about how to value future impacts in current terms, to make them comparable to the current costs of mitigation and adaptation. The IAMs employ discounting to evaluate and quantify a perceived declining importance of the long-term, when compared to the present and the short-term. A thorough discussion about discount rates goes well beyond the purpose of this document, but suffices to point out that, in Aotearoa, Māori views generally place more importance on the long-term future (Sense Partners, 2022) than the approaches introduced here by colonial administrations, and that have been the cornerstone of much government policy ever since (e.g., Treasury, 2024). This most recent government guidance suggests a 1.5% discount rate for projects with a horizon up to 2100, and 1.0% for projects whose benefits could be measured beyond 2100. Even a 1.0% discount rate, however, implicitly assumes that the year 2100 is about half as important for current assessment as 2025 (while the equivalent figure is about 30% for a 1.5% discount rate). Since IAMs generally use a range of discount rates around 2.0% (so that 2100 is only about 20% as important as 2025), their conclusions about the long-term impacts of climate change are severely under-estimated based on some culturally derived worldviews (Choy, 2018), and including specifically Māori worldviews (Sense Partners, 2022).

16. The high likelihood that the currently existing impact estimates are too low is also evidenced by the fact that as our knowledge about climate change increases over time, we understand the climate change impacts to be greater than was deemed previously. The Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change (IPCC, 2023) concluded that high and very high risks of all main climate change risk categories are currently estimated to occur at lower warming levels than was previously understood. This applies to economic impacts as well. A meta-analysis of

estimates shows that the social cost of carbon has increased over time (Tol, 2023) because older climate change cost assessments were underestimated. Despite improvements in the methods employed in assessments of climate change economic impacts, the latest estimates are still associated with large uncertainty and with a range of unquantified impacts.[2]

The Climate Change Commission's economic assessments

17. Economic assessments of climate change are used by the Climate Change Commission (The Commission) and by other government bodies. The Commission provides the government with independent evidence-based advice on climate change mitigation and adaptation. This advice concerns the recommended future levels of emissions, how emissions reduction can be achieved, and the unit limits and price control settings for the Emissions Trading Scheme, which is Aotearoa New Zealand's carbon pricing scheme. The Commission also informs the government and the public on climate change risks through National Climate Change Risk Assessment (NCCRA) reports and monitors and reviews the government's progress towards its adaptation goals.

18. The Commission takes economic quantifications of climate change costs into account for their assessment of economic risks, which then also influences their recommendations related to mitigation and adaptation. In the 2020 NCCRA report (MfE, 2020), both global (Stern, 2006; Hinkel et al., 2014) and national-level (Frame et al., 2018) assessments were considered. Climate change risks to the economy are considered by the Commission to be among the 10 most significant climate change risks. The Commission suggests that the "risks to governments from economic costs associated with lost productivity, disaster relief expenditure and unfunded contingent liabilities due to extreme events and ongoing, gradual changes" and the "risks to the financial system from instability due to extreme weather events and ongoing, gradual changes" may lead to extreme and major consequences, respectively (MfE, 2020, p. 9). These economic risks are also considered to

[2] Perhaps surprisingly, a recent meta-analysis of climate change economic impact estimates shows that this uncertainty has even been increasing over time, and that it is skewed towards negative surprises (Tol, 2024).

be associated with high urgency - 90/94 for the former, and 83/94 for the latter risk.

19. The Commission acknowledged that almost all climate change risks in NZ will ultimately have economic repercussions, including risks which may not immediately seem related to the economy, such as health impacts. Climate change cost assessments are also considered in the Commission's recommendations of emissions targets. For example, in the first review of the 2050 emissions target, the Commission considers various climate change assessments indirectly through referencing the conclusions of the IPCC AR6[3] that climate change impacts (including economic impacts) are now understood to be greater in both severity and scale than previously thought (Climate Change Commission, 2024).

Distribution of climate change impacts in NZ

20. The literature on the distribution of climate change impacts in Aotearoa New Zealand is scarce. It is generally understood that low-income households, which include a disproportionate number of Māori households, have a high level of socio-economic vulnerability and are and will continue to be disproportionately impacted by climate change due to their lower capacity to adapt (Hopkins et al., 2015). The vulnerability of Māori communities is exacerbated by many factors, including living in coastal and isolated communities with more vulnerable physical infrastructure and inadequate housing, having worse physical and mental health outcomes and higher rates of disability, having higher unemployment rates, less access to climate change related information, and living in areas that are already under environmental stress, all due to historical and current inequities in access to resources and due to policy biases (Harrington et al., 2023; Ihirangi, 2021). Many Māori lands and assets are more exposed to flooding and sea level rise (Lawrence et al., 2022). Furthermore, the Māori economy is more dependent on tourism and agriculture, both sectors that are especially exposed and vulnerable to climate impacts (Schulze et al., 2024). These skewed distribution of climate change impacts may thus further increase inequality and exacerbate poverty (Hopkins et al., 2015; King et al., 2010).

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3 The Intergovernmental Panel on Climate Change's 6th Assessment Report, published in 2021-23.

21. As regards the spatial distribution of climate change impacts, coastal communities are especially at risk (Rouse et al., 2017). More than a half of communities exposed to flooding reside in the upper half of the North Island in regions such as Northland, Tairawhiti, Waikato, and Bay of Plenty (DIA, 2022). Climate-change-related increases in insured residential property damages due to heavy rainfall events are projected mainly for the Southern and Northern regions of the South Island, and along the southwest coast of the North Island (Pastor-Paz et al., 2020). Changing drought conditions are expected to impact the primary sector especially in the eastern and northern parts of the country – especially Waikato and Canterbury (Lawrence et al., 2022). Notably, the 2023 Cyclone Gabrielle, which was very likely made more intense due to climate change, most severely impacted the regions of Gisborne and Hawke's Bay, which are home to a disproportionate number of Māori communities (Harrington et al., 2023; Stone et al., 2024). Gisborne, specifically, is home to the country's largest Māori population and has the highest levels of socioeconomic deprivation (Harrington et al., 2023).

Rationale for more urgent climate action

22. To summarise, the economic impacts of climate change in Aotearoa New Zealand are likely to be higher, and possibly much higher, than what current estimates predict. This is so because: (1) the existing methods of economic evaluation of climate change are based on inevitably simplifying assumptions that are necessarily erroneous. These assumptions exclude many consequential interlinkages between systems and therefore omit several important economic effects of complex inter-linking risks; (2) the methods largely exclude the adverse effects of worsening weather extremes; and (3) the estimates of economic impacts have been increasing over time as predictive capacity improves, and there are good reasons to believe that this will continue to be the case.

23. The negative economic impacts will be felt across the population, but are already disproportionately affecting vulnerable communities, such as low-income households and those at high risk of extreme weather events and sea level rise, including many Māori communities. These effects will increase poverty and exacerbate inequality and disadvantage.

24. In light of all this, the current policy settings for climate mitigation and adaptation are likely inadequate. It would consequently be beneficial to increase their ambition, scope, and pace. The need to do this for mitigation was acknowledged by the Climate Change Commission, which recently recommended to the government a more ambitious 2050 emissions reduction target, considering that: (1) climate change impacts are now understood to be more severe than was the case just several years ago; (2) the current level of global mitigation action is not sufficient to limit global warming to 1.5°C, and even to 2.0°C; and (3) comparable countries have set more ambitious mitigation targets than Aotearoa New Zealand (Climate Change Commission, 2024).

25. Lastly, another important reason that justifies more urgent action is based on the precautionary principle, which is often used as a guide in environmental decision-making more broadly. Accordingly, aggressive risk-ameliorating action is necessary when a non-trivial risk of significant negative outcomes exists, and scientific uncertainty about the likelihood of this risk should not be used to justify inaction (Kriebel et al., 2001; Weitzman, 2009). The application of the precautionary principle as it relates to climate change action is especially important given the possibility of future warming leading to catastrophic outcomes, such as a large-scale ecosystem collapse, massive economic disruptions, or even a societal collapse (Kemp et al., 2022; Lenton et al., 2019; Moriarty and Honnery, 2021). Even though the likelihood of these catastrophic outcomes is not high, and is uncertain, the catastrophic consequences of these scenarios warrant a strong response that lowers or eliminates their likelihood. In short, even if estimates of the average (likely) costs of climate change are relatively benign (and they are not), the low likelihood of catastrophic scenarios demands an aggressive action for the benefit of these future generations that could be affected by these catastrophes.

Ilan Noy

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