

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

How well do psychologists' research methods equip them to identify the impacts of climate change on behaviour? A methodological investigation with particular reference to the effects of temperature on violent behaviour

A thesis presented in partial fulfilment of the requirements for the degree of

Doctor of Philosophy
in
Psychology

at Massey University, Albany,
New Zealand

Matthew Neil Williams

2015

Abstract

The Earth's temperature is rising, and it is extremely likely that human activities are primarily to blame (IPCC, 2013b). A changing climate could have serious consequences for human behaviour and psychological functioning. Research concerned with the psychological impacts of climate change is challenging, however, given the paucity of data showing how human behaviour has responded to sustained climate changes in the past. In this thesis, I critique the suitability of psychologists' mainstream methodological strategies for engaging in research concerned with the impacts of climate change. In doing so, I draw heavily on a specific "testbed" of psychological research relevant to climate change: Research concerned with the impact of temperature on the incidence of intra- and interpersonal violence. In identifying methodological problems I draw both on published literature as well as an empirical engagement in research in this area. The empirical component constitutes an analysis of the relationship between temperature and the incidence of assault, suicide, and self-harm resulting in hospitalisation in New Zealand. In this analysis I found that irregular day-to-day variation in temperature had a positive relationship with all three forms of violence. However, there was less evidence that more sustained (seasonal or geographical) differences in temperature led to increased violence, making it difficult to predict the effects of sustained increases in temperature in the future. In the methodological critique section of this thesis, I point out several methodological problems that may hamper psychologists' capacity to produce effective and useful research concerned with the impacts of climate change. These problems include the use of measurement and analysis strategies that limit our ability to convey the sizes of effects; the use of theories and analyses that limit our ability to make predictions; and the inadequate reporting of uncertainty. Finally, I recommend that psychologists studying climate change impacts should consider using categorisations of behaviour rather than psychometric scales that lack clear units of measurement; use statistics that effectively communicate effect size; apply theories that facilitate prediction-making; carefully take into account the role of time when generating predictions; and account for multiple sources of uncertainty that affect the confidence of our conclusions.

Acknowledgements

This thesis may have my name on it, but many people have contributed to it. First thanks go to my supervisors Stephen Hill and John Spicer, who have been patient and helpful sources of wisdom throughout. I couldn't have asked for two better supervisors, and I certainly hope this isn't the last time we work together. I'd also like to thank the editors and reviewers who provided helpful feedback on the journal articles presented as part of this thesis. Any errors that remain are my own. Earlier in the process of my PhD, several organisations were very helpful in providing me with data, including the New Zealand Police, the Ministry of Health, the National Institute of Water and Atmospheric Research (NIWA), and Statistics New Zealand. Of particular help were Lynn Jenner, Gavin Knight, Steve Darroch, and Ruth Wallis (NZ Police); Jane Perrott and Chris Lewis (Ministry of Health); and Richard Speirs (Statistics NZ).

Margaret Roberts, Jaimie Veale, and Kirsty Furness were of great help when proofreading this thesis. Alison McKinlay deserves a lot thanks for sharing an office with me over these last few stressful months. Even more importantly, having the company of you four (and many others) also going through the trials and tribulations of doctorate study helped a lot. I'd also like to thank the inhabitants of the talkstats.com forums. What little I know about statistics is mostly thanks to all of you.

My parents Anneke and David have been amazing sources of love and support (and are great proofreaders too!) Thanks also to my brother and sister, Martin and Amy, for always being excellent and hilarious company. While writing of family, I'd also like to acknowledge my uncle Herman Gerhardus van Gysen, a researcher much more accomplished than I am who sadly died at the age of just 45. Herman's research was mainly focused on spline models in geodesy. I used spline models briefly in this thesis (see section 3.4.1), and I'm sure my analyses would have been much improved if I'd had him around to talk with.

Some PhD students manage to focus solely on their research for years at a time; I am not one of those students. I'd like to thank the volleyball crew for always being there when I needed a break and some exercise. The same goes for the longtime friends like Kris, Nick, and Rob who've been there since I first decided I'd like to spend another year... or two... at university.

Last but not least, I'd like to thank my wonderful partner Jessica. Finally, it's time for us to have a holiday.

Preface

This thesis takes the form of a partial thesis-by-publications format. Specifically, the empirical section of the thesis is presented as three journal articles. Studies One and Two were both published (in print and online) in *Climatic Change* in 2015. Study Three was published in *Psychology, Health, & Medicine* as an advance online publication in 2015. The final two chapters of this thesis (the methodological critique and methodological recommendations chapters) have not been submitted for publication. I chose not to structure these chapters as manuscripts in order to take advantage of the extra freedom in terms of space and format that a thesis allows. An additional short commentary article that I published in 2013 along with my supervisors, but that does not form a part of the main narrative of this thesis, is included in Appendix D.

The publishers of the three main articles presented in this thesis (Springer for *Climatic Change* and Taylor & Francis for *Psychology, Health & Medicine*) both provide authors with the right to include published articles in a thesis or dissertation. I contacted both publishers to confirm that this was acceptable in my specific case (i.e., a thesis that will ultimately be accessible online, with minor formatting changes to the articles presented). Representatives of both Springer and Taylor & Francis kindly confirmed that this was acceptable. The commentary article presented in Appendix D was published in an open access journal (the *Western Journal of Emergency Medicine*), meaning that it could be reproduced without obtaining permission from the publisher.

The work presented in this thesis is my own. I designed the empirical studies, collected data, selected and conducted data analyses, and wrote all of the chapters presented. My supervisors Stephen Hill and John Spicer helped me to select an appropriate structure, provided feedback on my writing, and provided valuable advice with respect to conceptual issues. They were therefore included as co-authors for the publications included in this thesis.

Ethical approval for the empirical studies reported in this thesis was obtained from the Massey University Human Ethics Committee, Southern B Application 10/54.

Matt Williams

Doctoral Candidate

Massey University

Table of Contents

Abstract	ii
Acknowledgements	iii
Preface.....	iv
Table of Contents	v
List of Figures	viii
List of Tables.....	ix
List of Abbreviations.....	xi
1 Introduction: Climate Change and Psychology	1
1.1 Anthropogenic Climate Change: Consensus and Consequences	2
1.2 The Current and Potential Contribution of Psychology to Climate Change Research	5
1.3 The Challenges of Studying the Psychological Impacts of Climate Change.....	8
1.4 The Methodological Readiness of Psychologists to Study the Impacts of Climate Change.....	13
1.5 The Testbed: Temperature-Violence Research.....	14
1.6 Conclusion.....	18
2 Study One: The Relationship between Temperature and Assault in New Zealand	20
2.1 Abstract	20
2.2 Introduction	21
2.3 Methods.....	25
2.4 Results	27
2.5 Discussion	34
2.6 Conclusions and Commentary	38
3 Study Two: Will Climate Change Increase or Decrease Suicide Rates? The Differing Effects of Geographical, Seasonal, and Irregular Variation in Temperature on Suicide Incidence	40
3.1 Abstract	40

3.2 Introduction	41
3.3 Methods.....	44
3.4 Results	46
3.5 Discussion	49
3.6 Acknowledgements	52
3.7 Conclusions and Commentary	52
4 Study Three: Do Hotter Temperatures Increase the Incidence of Self-Harm Hospitalisations?	55
4.1 Abstract	55
4.2 Introduction	56
4.3 Methods.....	57
4.4 Results	60
4.5 Discussion	64
4.6 Conclusions and Commentary	66
5 Methodological Critique	68
5.1 The Impacts of Climate Change: Requirements for Effective and Useful Research	69
5.2 The Suitability of Psychologists' Methodological Strategies for Meeting the Above Requirements	73
5.3 Conclusion	103
6 Methodological Recommendations.....	105
6.1 Use Measurement Strategies that Facilitate Clear Reporting of Effect Size	105
6.2 Report Findings Using Unstandardised Effect Sizes	113
6.3 Develop and Apply Theory that Facilitates Useful Prediction-Making	114
6.4 Take Into Account the Role of Time	117
6.5 Improve the Modelling and Reporting of Uncertainty.....	121
7 Conclusions	137
8 Consolidated Reference List	139

9 Appendix A: Supplementary Materials for Study One (Assaults).....	180
9.1 Introduction.....	180
9.2 Methods.....	180
9.3 Results.....	188
10 Appendix B: Supplementary Materials for Study Two (Suicides).....	203
10.1 Additional Information about Methods.....	203
10.2 Additional Information about Results.....	207
11 Appendix C: Supplementary Materials for Study Three (Self-Harm).....	213
11.1 Introduction.....	213
11.2 Additional Information about Methods.....	213
11.3 Additional Information about Results.....	218
12 Appendix D: Temperature and Violent Crime in Dallas, Texas—Published Commentary.....	225
13 Appendix E: Statements of Contribution for Publications.....	228

List of Figures

Figure 1. Changes in the global surface air temperature.....	3
Figure 2. Scatter plots of temperature and recorded assaults in Auckland, Wellington, and Canterbury, and of temperature and assaults resulting in hospitalisation (nationally averaged).....	28
Figure 3. Mean daily recorded assaults by month and region.	29
Figure 4. Trends in recorded assaults and temperature; averaged across Auckland, Wellington, and Canterbury.	31
Figure 5. Visually-weighted non-linear regression analysis of the effects of irregular variation in temperature.	47
Figure 6. Mean daily suicides per 100,000 and temperature by month.	48
Figure 7. Geographical variation in temperature versus suicide rate.....	49
Figure 8. Self-harm incidents and temperature by month.....	62
Figure 9. Trends in temperature and self-harm resulting in hospitalisation in New Zealand, 1993–2009.....	64
Figure 10. Mean daily assaults resulting in hospitalisation and temperatures by month.	197
Figure 11. Trends in assaults resulting in hospitalisation over the study period.	202

List of Tables

Table 1 Coefficients for Geographical Variation Models	61
Table 2 Coefficients for Seasonal Variation Models	62
Table 3 Coefficients for Irregular Daily Variation Models	63
Table 4 Virtual Climate Stations Utilised	186
Table 5 Seasonal Variation in Temperature and Recorded Assaults: Model Coefficients	191
Table 6 Irregular Daily Variation in Temperature and Recorded Assaults: Model Coefficients	192
Table 7 Heat Waves and Recorded Assaults: Model Coefficients	195
Table 8 ENSO and Recorded Assaults: Model Coefficients	196
Table 9 Seasonal Variation in Temperature and Assaults Resulting in Hospitalisation: Model Coefficients	198
Table 10 Irregular Daily Variation in Temperature and Assaults Resulting in Hospitalisation: Model Coefficients	199
Table 11 Geographical Variation in Temperature and Assaults Resulting in Hospitalisation: Model Coefficients	201
Table 12 Irregular Variation in Temperature and Suicides, Contemporaneous Effects: Coefficients for Poisson Generalised Linear Mixed Model.....	208
Table 13 Irregular Variation in Temperature and Suicides, with Lagged Effects: Coefficients for Poisson Generalised Linear Mixed Model.....	209
Table 14 Seasonal Variation in Temperature and Suicides: Coefficients for Poisson Generalised Linear Mixed Model	210
Table 15 Geographical Variation in Temperature and Suicides: Coefficients for Poisson Generalised Linear Model.....	210
Table 16 Geographical Variation in Temperature and Suicides: Coefficients for Poisson Generalised Linear Model with Age and Ethnicity Controls.....	211
Table 17 Geographical Variation in Temperature and Suicides: Coefficients for Poisson Generalised Linear Model with Age, Ethnicity and Radiation Controls	211
Table 18 Estimated Effect of Geographical Variation in Temperature, by Season: Coefficients from Poisson Generalised Linear Mixed Model.....	212
Table 19 Virtual Climate Stations Used	215
Table 20 Coefficients for Quasi-Poisson Geographical Variation Models.....	220

Table 21 Comparing Bayesian and Frequentist Models: Coefficients for Temperature	
.....	224

List of Abbreviations

ANOVA/ANCOVA	Analysis of variance/Analysis of covariance
AWS	Automatic Weather Station
CI	Confidence interval
<i>df</i>	Degrees of freedom
ENSO	El Niño Southern Oscillation
ICD	International Classification of Diseases
IPCC	Intergovernmental Panel on Climate Change
<i>M</i>	Mean
MJ/m ²	Megajoules per square metre (of radiation)
NASA	National Aeronautics and Space Administration
NIWA	National Institute of Water and Atmospheric Research
NZ	New Zealand
RCP	Representative Concentration Pathway
<i>SD</i>	Standard deviation
SI	International System of Units
SOI	Southern Oscillation Index
T _{mean}	Mean temperature
US/USA	United States of America
VCN	Virtual Climate Network