Assessing the Influence of Hurricane Fiona on Dalhousie Students' Perceptions of Psychological Distance to Climate Change and Adoption of Sustainable Behaviours

Final Report

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Abstract

This report analyzes the influence of Hurricane Fiona on Dalhousie University students' perceptions regarding the reality of increased Atlantic Canadian hurricanes and their connection to unsustainable consumption patterns and behaviours. Through a survey-based approach targeting students present during Hurricane Fiona's landfall, the research associated with this report aims to determine correlations between hurricane impact and psychological distance to climate change. The research centers on establishing how the hurricane influenced students' perceptions of climate change, including more specific factors associated with the degree of psychological detachment from climate change while measuring the change in student adoption of sustainable habits. Hypotheses posit positive correlations between hurricane impact and psychological distance to climate change and between hurricane impact and adoption of sustainable behaviours. Data analysis involves confirmatory factor analysis (CFA) and structural equation modelling (SEM) to test these relationships. However, the study faces limitations due to a smaller-than-desired sample size, potentially impacting the generalizability and reliability of findings. Despite these limitations, the report provides insights into how hurricanes can shape students' perceptions and behaviours related to climate change.

Key words

Halifax, Student, Housing, Environment, Safety, Finances, Disaster, Psychology, Hurricane, Social, Wellbeing.

Introduction

Background and rationale

Hurricanes are powerful weather systems that draw heat from tropical waters to intensify their ferocity. These turbulent storms typically begin as tropical waves, characterized by low-pressure systems traversing the moisture-laden tropics, potentially causing increased rainfall and thunderstorm activity (NOAA, 2023). The storm's vigour is sustained by oceanic temperatures of at least 26.5 degrees Celsius (°C) across a depth of 50 metres. Progressing westward over tropical regions, warm oceanic air ascends within the storm, generating a zone of decreased atmospheric pressure below, prompting further air influx (NOAA, 2023). As the ascending air cools, cloud formations and thunderstorms ensue. Within the clouds, water vapour condenses into droplets, releasing additional heat, thus reinforcing the storm's strength. Upon attaining wind velocities of 74 mph or 119 km/h, the storm is classified as a hurricane, typhoon, or tropical cyclone (NOAA, 2024). The term given to the storm varies based on its geographical origin. The term hurricane is employed in the North Atlantic, central North Pacific, and eastern North Pacific, while it is referred to as a typhoon in the Northwest Pacific (NOAA, 2024). In the South Pacific and Indian Ocean, regardless of wind intensity, the term tropical cyclone is universally used to describe such weather phenomena.

Given the established understanding that hurricanes develop over relatively warm ocean surfaces, this has fostered the belief that global warming will significantly amplify hurricane activity on a global scale. The impact of greenhouse gas (GHG)-induced changes in sea surface temperature (SSTs) on hurricane frequency and intensity is a pressing concern with wide-ranging implications. Studies indicate that a doubling of carbon dioxide could result in a substantial 40 - 50% increase in hurricane potential intensity (Trenary et al., 2019, pp. 3378-3379). High-resolution projections reinforce this, illustrating a correlation between rising GHG concentrations and heightened hurricane intensity. Current evidence from advanced models suggests a global average intensity increase of approximately 5%, accompanied by a 13% rise in the proportion of more severe storms like Category 4 and 5 hurricanes (Spencer & Strobl, 2020, p. 337). Notably, over half of the observed increase in global mean surface temperature from 1951 to 2010 is likely attributable to escalating GHG concentrations. Consequently, the anticipated changes in surface temperature are expected to manifest in hurricane frequency and intensity.

In September 2017, Hurricane Irma, initially a category 5 storm in the Atlantic, made landfall in Florida as a category 4 hurricane, causing extensive damage to coastal areas across the state, including Sarasota. Situated at the southern end of Tampa Bay, Sarasota is identified as one of the most susceptible American cities to the effects of climate change. The impact of Hurricane Irma led to widespread evacuation, significant damage to local properties, and prolonged power outages for many residents (Hao et al., 2020, p. 1). The limited firsthand experience of climate-

induced disasters among Americans has contributed to skepticism regarding the reality of climate change. To explore the potential influence of Hurricane Irma on perceptions of climate change, a study was conducted in Sarasota one year following the hurricane. The objective was to ascertain whether the perceived impact of the hurricane had bridged the psychological gap associated with climate change and fostered greater belief in its existence (Hao et al., 2020, p. 1). Data for this study were collected through a survey focusing on latent-constructed variables, including beliefs of climate change, support for related policies, engagement in environmental actions, and the perceived impact of Hurricane Irma (Hao et al., 2020, p. 4). The findings revealed a positive correlation between the perceived impact of Hurricane Irma and the acceptance of climate change as a phenomenon influenced by human activity (Hao et al., 2020, p. 5). These results align with the expectations of construal level theory, suggesting that the experience of the hurricane brought the issue of climate change closer psychologically, thereby reinforcing belief in its significance. Furthermore, the findings supported a modified belief-to-action framework, indicating that belief in climate change can motivate individuals to advocate for environmental policies and participate in efforts aimed at environmental conservation (Hao et al., 2020, p. 5). This can be seen through another study that focused on Culebra, an isolated island near Puerto Rico, which faced exacerbated environmental health risks following Hurricanes Irma and María in 2017 (Pérez-Ramos et al., 2019, p. [Page 231]). Community attitudes and perceptions towards environmental health risks were explored through interviews before and after the hurricanes. Factors like mosquito presence, waste disposal, water quality, and tourism were highlighted (Pérez-Ramos et al., 2019, p. [Page 239]). The study emphasized the need for sustainable, community-engaged strategies to address health disparities and respond to ecological challenges. This collective approach and deep-rooted island community identity in Culebra serves as a potential model for other island communities facing similar crises, including severe natural disasters such as hurricanes (Pérez-Ramos et al., 2019, p. [Page 240]).

Examining a less spatially distant storm, Hurricane Fiona stands out as a large and intense hurricane that made landfall in Puerto Rico, the Dominican Republic, Grand Turk, and eventually Nova Scotia. On September 24th, 2022, Fiona hit the southeastern coast of Nova Scotia as an exceptionally strong extratropical cyclone, with maximum winds near 85 knots (kt) and a minimum pressure of 931 millibars (mb) (Pasch et al., 2023, p. 4). Hurricane Fiona holds the record as the deepest cyclone by minimum pressure to make landfall in Canada. The aftermath of such powerful storms extends beyond physical damage to include significant impacts on mental well-being. Individuals experiencing a disaster may react with anxiety or posttraumatic stress disorder, with these changes often manifesting weeks or months after the event (Aponte, 2018, p. 110). At times, a traumatic or frightening experience can cause the development of a mental health disorder or worsen an existing one. Hurricane Fiona, one of the most powerful and destructive storms in Canadian history, has left a lasting imprint on both economic and mental well-being. Residents living along the coast, in particular, may suffer from lingering trauma triggered by the ocean, waves and associated noises — reminders of the near-

death experiences and destruction they endured (Rachini, 2022). The mental health repercussions from Fiona highlight the importance of addressing not only the immediate physical aftermath of such events but also the long-term psychological impact on affected communities.

Research question

How did Hurricane Fiona influence Dalhousie University students' perceptions of the reality of increased Atlantic Canadian hurricanes and their relation to unsustainable consumption-based behaviours?

Objectives

To survey Dalhousie students who were present during Hurricane Fiona's landfall, questioning them about: a) their demographics, b) impact from the hurricane and degree of financial/physical/emotional concern, c) degree of belief in climate change, d) degree of psychological distance to climate change post-Fiona, and e) altered sustainable practices post-Fiona. This project aims to ascertain potential positive correlations between variables a), b), and c) with variables d) and e), to assess whether the hurricane's impact reduced psychological distance to climate change and enhanced sustainable behaviours among students.

Hypotheses

1) Our alternative hypotheses are that the degree of economic, social, and mental impact Hurricane Fiona had on students is positively correlated with their closeness of psychological distance to climate change and positively correlated with their adoption of more sustainable behaviours.

2) Our null hypotheses are that the degree of economic, social, and mental impact Hurricane Fiona had on students shows no correlation with their closeness of psychological distance to climate change and with their adoption of more sustainable behaviours.

Methods

Study design

To determine the correlation between the impact of Hurricane Fiona on students' psychological distance to climate change and adoption of sustainable behaviours, we employed a survey and primarily quantitative data rather than more qualitative measures like interviews or focus groups. Because our objectives are mainly supported by relational data analysis like correlation, and qualitative coding of long responses is an arduous task given our desired sample size. We concluded an online survey was the most comprehensive and effective means of

sampling. Much of what is known about demographic climate change belief and impact comes from surveying, albeit at much larger scales (Drews & van ded Bergh, 2015, Bostrom et al, 2012, Leiserowitz et al, 2011). The first section of our survey required respondents to sign the ethics form and confirm they fit the criteria necessary to take the survey. The second section asked respondents about sociodemographic variables (age, year of study, gender, housing situation, and previous hurricane experience). The third section asked respondents a series of questions encompassing four latent constructed variables (LCVs): belief in climate change, perceived impact of Hurricane Fiona, psychological distance to climate change, and causally adopted sustainable behaviours. Lastly, we asked respondents a few open-ended questions on the nature of our study and included a field within which they could input their email addresses for a $50 Amazon gift card draw. The card expense was incurred equally by group members and distributed to the winner immediately following a randomized draw upon the survey's closure.

Sample size

To determine the sample size emblematic of a confidence level of 95%, a margin of error of 5%, and a population proportion of 50 (the recommended levels for ENVS3502), we estimated the number of students who fulfill the criteria of our target demographic. Our study aims to survey people who fit the following criteria: any Dalhousie University Studley campus students living, studying, *and* present in the province of Nova Scotia during Hurricane Fiona's landfall on September 24, 2022. Dalhousie's most recent available report of enrollment statistics, dated December 1, 2022, tabulates a student body of 21,088 (Dalhousie University, 2023, 2023/2024 Enrolment…). It is difficult to estimate a minimum sample size for our study due to several unreported factors within available enrollment data; students ideally excluded include current 'first-year' students who were out-of-province at landfall, non-present upper-year students, online students, and more. Of these exclusions, we could only calculate the first; assuming one-quarter of undergraduate students are 'first-year' ($16{,}024 \times 0.25 = 4{,}006$) and as Dalhousie reports, 63% of students are from out-of-province, our population becomes 18,564 ($21{,}088 - 4{,}006 \times 0.63 = 18{,}564$) (Dalhousie University, 2023, *About*…). Understanding the unquantified aforementioned assumptions and confidence standards, we used Calculator.net to determine a minimum sample size of 377 students. By the closing of our survey, our final collected sample size was 79, representing a high margin of error (11%) at a 95% confidence level. Our low sample size will remain a limitation throughout the data analysis but will be elaborated upon later.

Recruitment materials

We constructed four primary recruitment materials to survey a sample size as wide as possible. We created a poster and handout using the free design software Canva (Appendices 1 and 2). Both materials contained a QR code generated from a Google Forms plug-in, which directed respondents to our survey. Both materials also included Dalhousie undergraduate approval, one of our email addresses, and an advertisement for our fifty-dollar Amazon gift card incentive. Posters were hung up on March 12 throughout the Studley campus in the Killam Memorial Library, the 'tunnel,' the Life Sciences Centre (LSC), and the James Dunn Building. They were removed two weeks later upon survey closure. Our handouts were four-by-three-inch truncated versions of our poster. We handed out a total of 120 slips to studying students (in groups or alone) across three campus buildings (Killam, LSC, and the Student Union Building (SUB)). Our third recruitment method involved a promotional email blast to students on the mailing list of the Dalhousie Earth and Environmental Science program on March 14 (Appendix 3). We reached out to five Dalhousie science societies and requested for our poster to be uploaded to their Instagram stories, where they remained visible for twenty-four hours: Environmental Programs Student Society (EPSS), Your Environmental Sustainability Society (YESS), Dawson Geology, Dal Biology, and Dal Marine Biology. The first three complied. Our poster was also digitally promoted in lecture slides and Brightspace announcements of two Dalhousie courses, ENVS3200 and ENVS3601. Lastly, we each uploaded the poster to our own Instagram accounts once, on March 14.

Tools

Surveying was conducted via Google Forms. Recruitment materials were designed on Canva. Data analysis was conducted on Google Sheets, Microsoft Excel, and RStudio. The SEM diagram was created using Microsoft PowerPoint. CFA and SEM were performed on RStudio with the package 'lavaan' and aided greatly by online lectures publicly available from UCLA's Statistical Consulting Group (UCLA, n.d.).

Outline of data analyses

Survey results were numerically coded for quantitative assessment. Among statisticians, substantial scientific debate exists on the validity of coding, say, five-point Likert-style questions via a 1-5 assigning scale (Pell, 2005, Carifio & Perla, 2007). Likert-style questions are primarily thought of as ordinal; that is, responses can be ordered via some scale of severity or intensity. However, the distance between similarly spaced points on the scale may not be considered equidistant, whether due to the researcher's biases or the respondent's perceptions. This "50 year… great debate" between those with ordinalist versus intervalist views has not been resolved. Still, many contemporary statisticians argue that meaningful data can, and often should be extracted from parametric analysis of Likert-style questions:

> "It is… perfectly appropriate to summarize the rating generated from Likert *scales* using means and standard deviations…. parametric techniques like analysis of variances… [and] correlations as the basis for various multivariate analytical techniques" (Carifio & Perla, 2008).

As such, we contest that our numerical coding of Likert-style questions is appropriate and generates meaningful results, in accordance with other peer-reviewed climate change polling literature (Hao et al, 2020).

To reveal relationships between the three variables concerning our alternative hypotheses, we used three data analyses against our survey results. Confirmatory factor analysis (CFA) is a statistical analysis used mainly in the social sciences to identify relationships between unmeasured latent constructed variables (LCVs), such as attitudes, beliefs, and impacts, and the measured items of which they are made up, such as responses to individual questions (Jackson et al, 2009, DiStefano & Hess, 2005). CFA has been used in a growing number of studies on perceptions of climate change, where survey responses are used to create latent constructed variables, modeling how such variables act as influences to such perceptions (Wu et al, 2023, Masud et al, 2016, Furlan & Mariano, 2022). CFA was chosen over exploratory factor analysis (EFA) as we constructed our LCVs from survey questions *a priori* based on our hypotheses (Tavakol & Wetzel, 2020). Four LCVs were identified as a) belief in climate change, b) perceived impact, c) psychological distance and d) behavioural change.

Belief in climate change was constructed from survey questions on belief in the past, present, and future climate change in Nova Scotia, all of which had a five-point Likert-style field of responses. Another question inquired about climate change worry, from not worried at all (1) to severely worried (5). Lastly, one question asked about the degree to which respondents believe climate change is anthropogenically caused, from entirely natural processes (1) to entirely anthropogenic processes (5). Perceived impact was measured with six questions: days of lost power (numerical interval), worry of days of lost work, worry of damages to possessions and property, worry of lost recreation and routine, worry of personal safety and security, and worry of pre-existing mental health condition exacerbation (all five-point Likert). The psychological distance was measured with four Likert-style agreement questions based on the four dimensions outlined by the Trope and Liberman (2010) Construal-Level Theory: hypothetical, physical, temporal, and social. Behavioural change was measured with three Likert-style agreement questions, denoting sustainable shift in transportation, consumption, and dietary behaviours due to Hurricane Fiona's impacts.

A number of sociodemographic variables were also surveyed. Gender (Knight, 2019), political affiliation (McCright, 2011), income, education, and race (Teyton & Ambramson, 2021) are arguably the five most strongly correlated measures with climate change belief. Our sample

frame of mostly science major university students is likely to have a largely similar political affiliation, income, and education, so we did not investigate those as relevant factors in our analyses. Race was also not included as it was irrelevant to our research question. However, we surveyed for gender, in addition to year of study, age, housing situation, and past hurricane experience. The year of study was coded as follows: first-year undergraduate (1), second-year undergraduate (2), third-year undergraduate (3), four-year undergraduate (4), fifth-or-greater-year undergraduate (5), Master's student (6), PhD student (7), post-Doctorate student (8). The housing situation was coded as follows: Dalhousie residence (1), student-house (2), apartment of less than ten floors (3), apartment of more than ten floors (4), family-style home (5). Past hurricane experience was coded as follows: having experienced a hurricane of greater intensity (0), Hurricane Fiona being the first or most intense hurricane (1).

The CFA-identified factors were analyzed with structural equation modelling (SEM), a statistical technique which tests the significance of the association between LCVs to the fit of an *a priori* constructed model. SEM is similarly used in climate change opinion research (Dang et al, 2014, Sasaki et al, 2019, Ankamah et al, 2021, Haladay Rao et al, 2017). Our model (Figure 1) hypothesized belief in climate change to be associated with psychological distance, perceived impact to be associated with both psychological distance and behavioural change, and psychological distance to be associated with behavioural change. The survey items verified in the CFA remained attached to their LCVs. In addition, each LCV was modeled with attachment to the five aforementioned surveyed sociodemographic variables.

Results

Descriptive statistics of our latent constructed variables and sociodemographic variables are given in Table 1 and Table 2.

Table 1: Descriptive statistics of latent constructed variables.

		Range	Mean	S. D.
Belief in climate change	Belief in current climate change	1—5	2.73	0.96
	Belief in past climate change	1—5	3.73	0.83
	Belief in future climate change	1—5	4.09	0.82
	Climate change worry	1—5	3.92	1.10
	Belief in the anthropogenic nature of climate change	1—5	3.92	0.57
Perceived impact	Days of lost power	0—14	3.35	2.64
	Financial worry of days of lost work	1—5	2.19	1.21

	Financial worry of damages to possessions or property	1—5	3.05	1.14
	Mental worry of lost recreation or routine	1—5	3.14	1.17
	Physical worry of safety or security	1—5	3.03	1.25
	Exacerbated mental health conditions	1—5	2.49	1.42
Psychological distance	Hypothetical distance	1—5	3.37	0.83
	Physical distance	1—5	3.53	0.87
	Temporal distance	1—5	3.29	0.90
	Social distance	1—5	3.46	0.89
Behavioural change	Transportation behaviours	1—5	2.67	1.03
	Consumption behaviours	1—5	2.71	1.15
	Dietary behaviours	1—5	2.33	1.02

Table 2: Descriptive statistics of sociodemographic variables.

	Range	Mean	S. D.
Age	17—34	19.27	2.39
Year of study	1—8	2.28	1.47
Gender (male = 0)*	0—1	0.87	0.33
Housing situation	1—5	2.43	1.36
Hurricane experience	0—1	0.78	0.41

*Note: Gender identity was surveyed with a third write-in field for those who do not identify as male or female (Canada, 2021). However, we received no responses other than male or female.

The results in Table 3 show the standardized coefficient loadings of each individual item. (*) denotes items that are greater than 0.5 and therefore statistically significant at the 0.001 level, and therefore considered reliable measurements of their respective factors (Xiao et al, 2012, Hao et al, 2020). Three insignificant items are removed from the SEM: climate change worry, belief in the anthropogenic nature of climate change, and days of lost power.

Table 3: Confirmatory factor analysis results.

	Belief in climate change	Perceived impact of Hurricane Fiona	Psycholo-gical distance	Behaviou-ral changes
Belief in current climate change	0.631*			
Belief in past climate change	0.834*			

Belief in future climate change	0.736*			
Climate change worry	0.490			
Belief in the anthropogenic nature of climate change	0.101			
Days of lost power		0.371		
Financial worry of days of lost work		0.539*		
Financial worry of damages to possessions or property		0.529*		
Mental worry of lost recreation or routine		0.634*		
Physical worry of safety or security		0.787*		
Exacerbated mental health conditions		0.514*		
Hypothetical distance			0.759*	
Physical distance			0.871*	
Temporal distance			0.572*	
Social distance			0.727*	
Transportation behaviours				0.671*
Consumption behaviours				0.992*
Dietary behaviours				0.790*

Table 4 shows the standardized coefficients of our hypothesized relationships represented in Figure 1. The coefficients measure the strength of association the variable written in the column on the left has on the variable listed on the variable written in the row on the top; for example, the standardized coefficient 0.133 represents the positive association between belief in climate change and psychological distance. (*) denotes significance (Hao et al, 2020). Model fit statistics are considered in the Discussion.

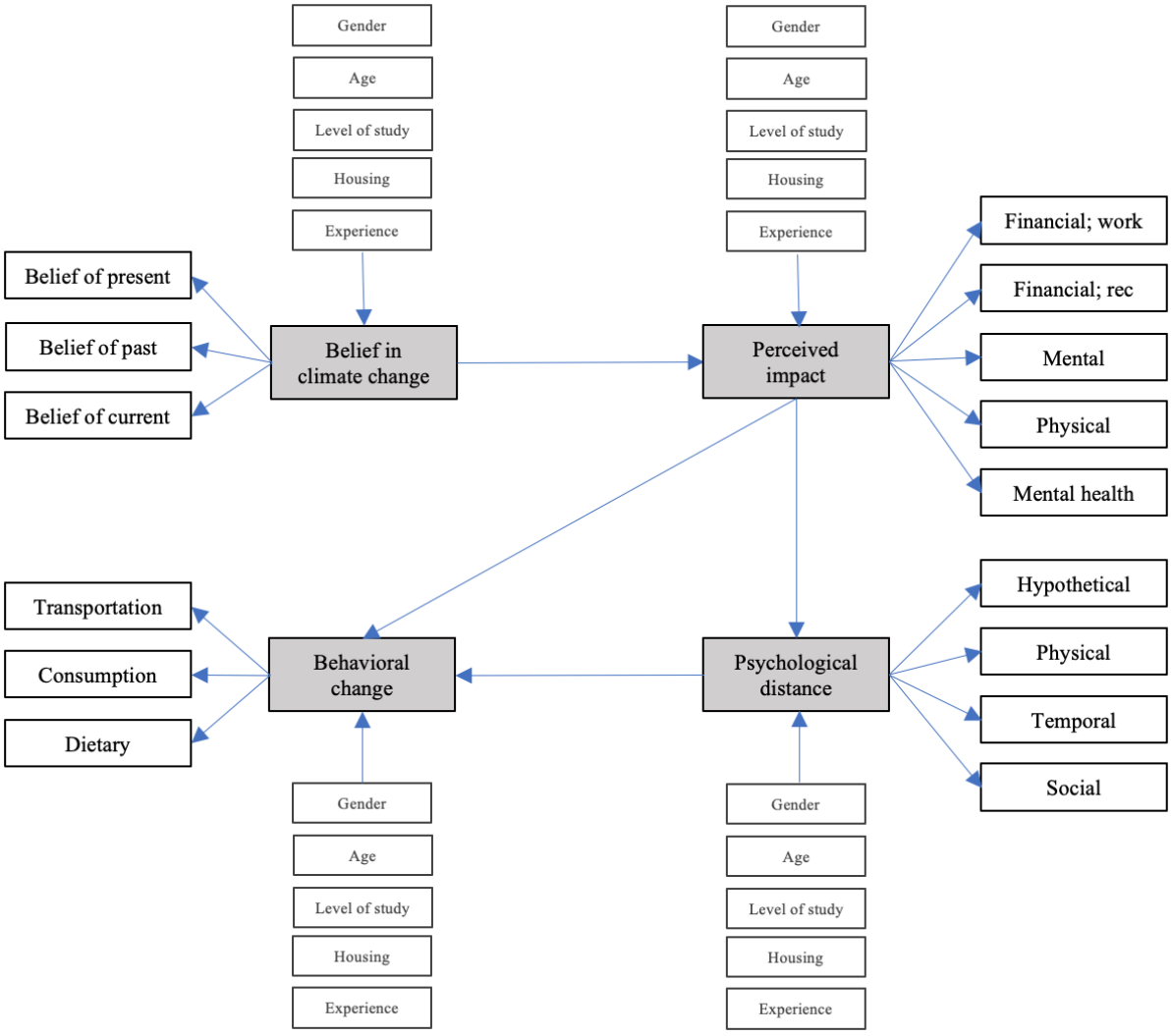


Figure 1: Structural equation modelling diagram. LCVs indicated in gray boxes. Individual arrows for socio-demographic variable associations not shown for clarity.

Table 4: Structural equation modelling results.

	Psychological distance	Behavioural change
Standardized coefficients		
Belief in climate change	0.133	
Perceived impact of Hurricane Fiona	0.750*	-0.527*
Psychological distance		0.965*
Model fit statistics		

RMSEA	0.01	
CFI	0.79	
TLI	0.734	

The weakness of the SEM (elaborated on in the Discussion) prompted a different, more straightforward statistical analysis. Items within the CFA-supported factors were averaged into three individual scores per survey respondent: Hurricane Fiona impact score, psychological distance score, and behavioural change score. A simple linear regression and correlation analysis between these scores was run on Excel and displayed in Figure 2 and Table 5.

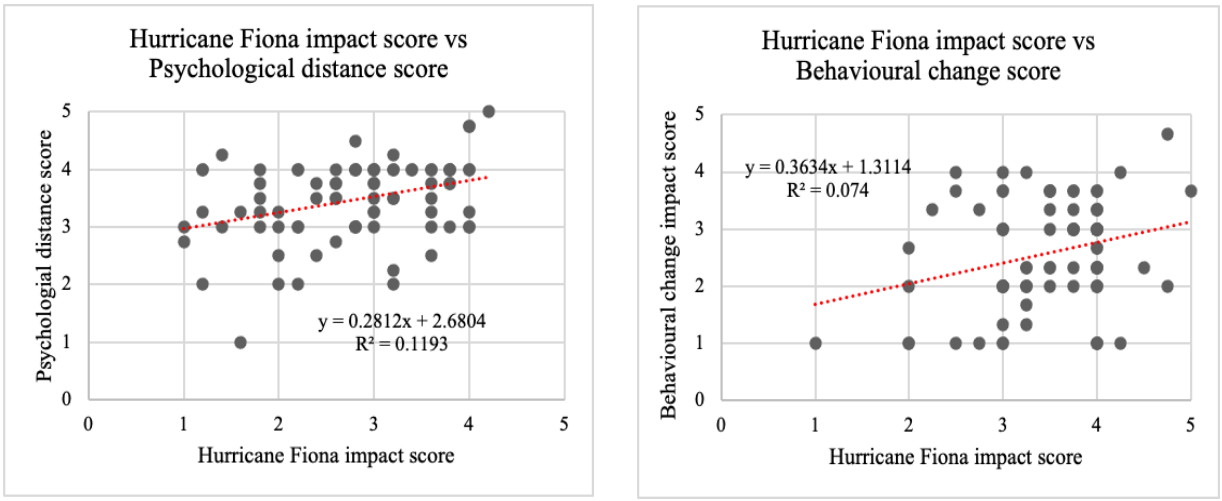


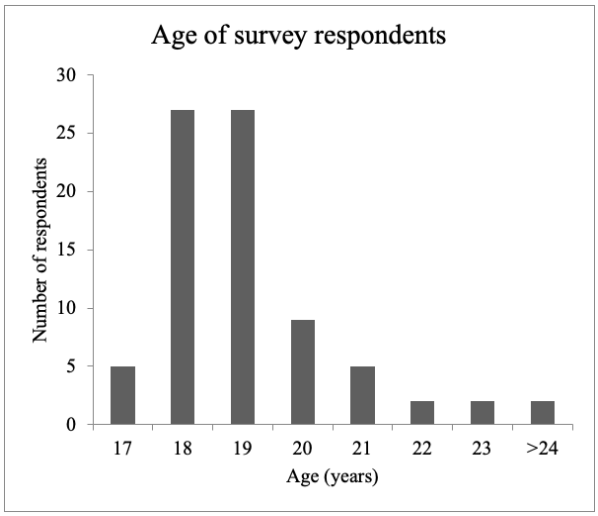
Figure 2: Results of a linear regression analysis between Hurricane Fiona impact score, psychological distance score ($y = 0.281x + 2.680$, $R^2 = 0.119$) and behavioural change score ($y = 0.363x + 1.311$, $R^2 = 0.074$).

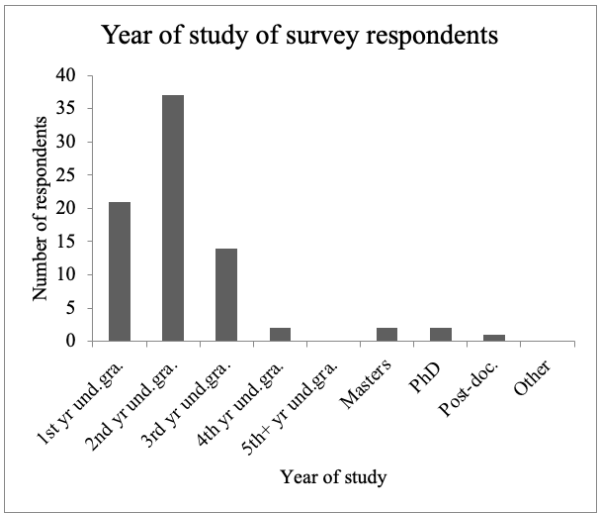
Table 5: Result of a correlation analysis between Hurricane Fiona impact score, psychological distance score, and behavioural change score. Strong correlation is denoted as greater than 0.5, as per ENVS3502 standards.

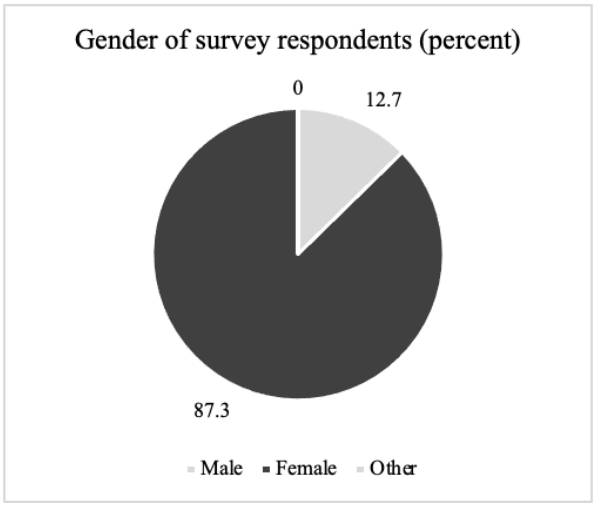
	Hurricane Fiona impact	Psychological distance	Behavioural change

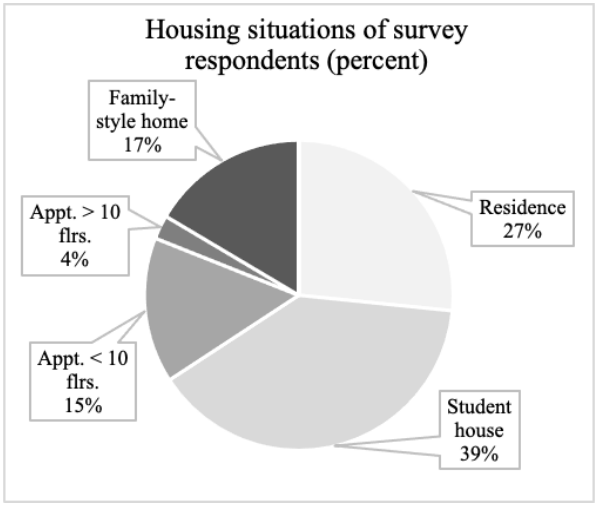
	score	score	score
Hurricane Fiona impact score	1	—	—
Psychological distance score	0.344	1	—
Behavioural change score	0.437	0.272	1

Other notable results of sociodemographic measures and LCVs are displayed in the figures below.









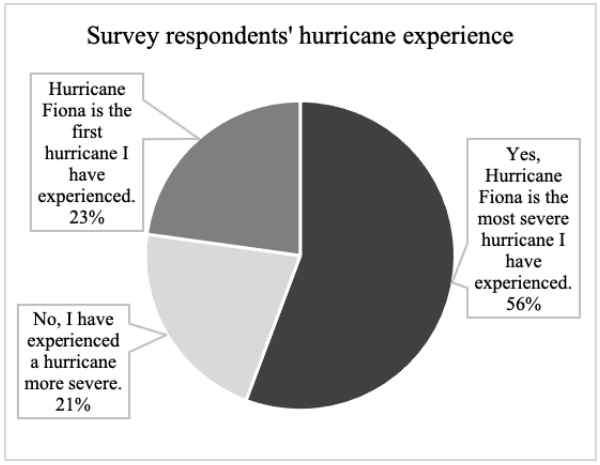
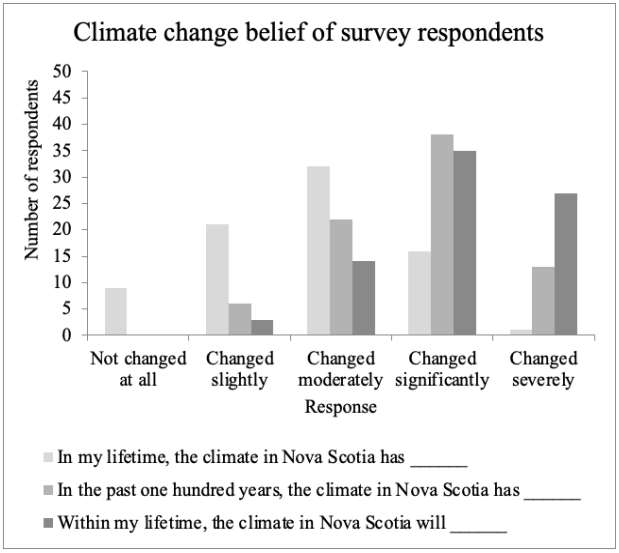
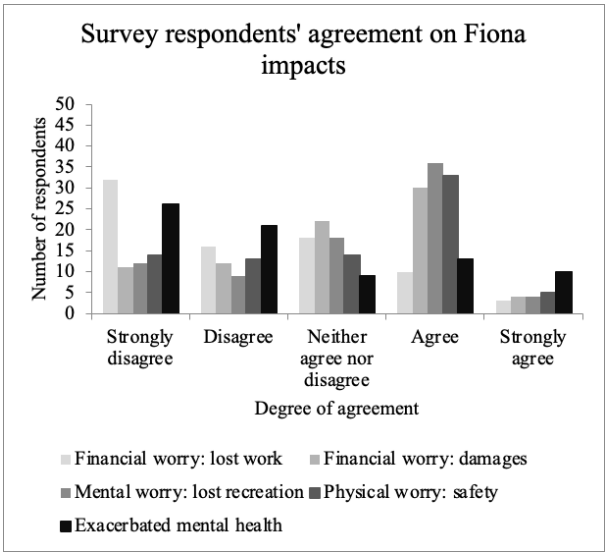
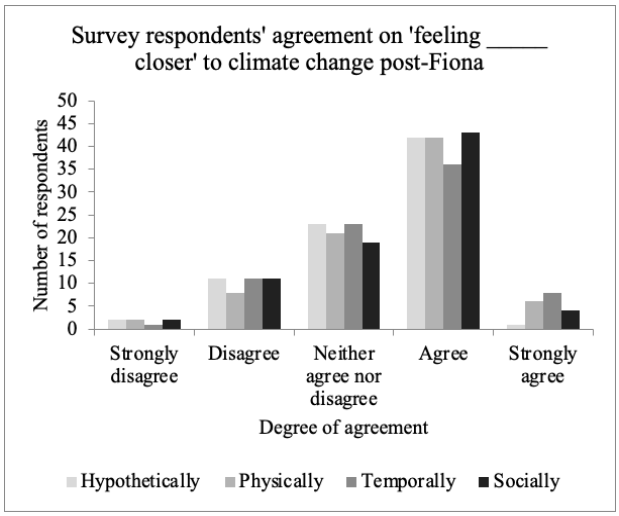


Figure 2: Summary statistics of five sociodemographic

variables: a) age, b) year of study, c) gender, d) housing situation, and e) previous hurricane experience.







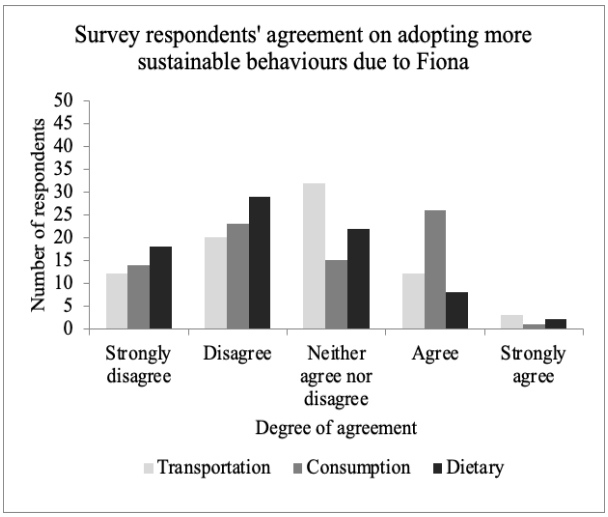


Figure 3: Summary statistics of the four LCVs: a) belief in climate change, b) impact of Hurricane Fiona, c) psychological distance, and d) behavioural change

Discussion

This study aimed to determine if there was a significant correlation between Dalhousie students' impacts incurred by Hurricane Fiona and their post-Fiona psychological distance to climate change and adoption of sustainable behaviours. Informed by other contemporaneous studies on climate change belief and extreme weather impact, we completed a CFA and SEM to test for these associations (Hao et al, 2020, Tengjiao et al, 2020, Furlan & Mariano, 2022). The CFA results indicated that nearly all of our survey items were adequate measures of our factors; three items, however, responded as insignificant: days of lost power (as a measure of hurricane impact), and climate change worry and belief of anthropogenic nature of climate change (as measures of belief of climate change). Days of lost power was likely insignificant due to the format for which we designed its measure in the survey. It was the only question which allowed for any numerical response, ultimately ranging from 0—14 (Table 1), whereas every other

question in the factor was Likert-style. Though CFA adjusts for questions with different scales, this wide range likely limited any verifiable agreement alongside the other questions in the factor (UCLA, n.d.). For a future survey, we recommend that all items within the same factor be scaled the same or very similarly. For example, this question could have been reworded to a five-point scale with response options such as no days of lost power (1), 1—2 days of lost power (2), 3—4 days of lost power (3), and so forth (Hao et al, 2020). In retrospect, climate change worry and belief in the anthropogenic nature of climate change are not good items to represent belief in climate change. Robust surveys of climate change perception are only recently being developed (van Valkengoed et al, 2021) in an attempt to merge variably structured assessments in previous literature (Clayton et al, 2015, Hornsey et al, 2016). For a future survey, climate change worry and questions on anthropogenic influence should be restructured or unincluded in assessing climate change belief. Furthermore, our survey could have been fortified with questions validated by van Valkengoed et al, 2021. However, we acknowledge that keeping the survey short was important in maximizing the response rate.

The SEM yielded coefficients which can be summarized in the following statements: there is *no significant* relationship between belief in climate change and closer psychological distance (which rejects our alternative hypotheses), there is a *significant positive* relationship between impact of Hurricane Fiona and closer psychological distance (which supports our alternative hypotheses), there is a *significant negative* relationship between the impact of Hurricane Fiona and adoption of sustainable behaviours (which rejects and counters our alternative hypotheses), and there is a *significant positive* relationship between closer psychological distance and adoption of sustainable behaviours (which supports our alternative hypotheses). Within the model, these statements are supported, however, the model itself was revealed to be insignificant upon calculation of its model fit statistics. Three model fit statistics were assessed in accordance with a similar SEM conducted by Hao et al, 2020: root mean square error of approximation (RMSEA), comparative fit index (CFI), and the Tucker-Lewis index (TLI). RMSEA is the most commonly reported model fit statistic in CFA and SEM, however, it can show misleadingly strong significance with small sample sizes (Kenny et al, 2014). Though a value of 0.01(Table 4) indicates an excellent fit (MacCallum et al, 1996), it is argued that RMSEA should not even be reported in models with a small sample size, considering a similar survey with a sample size of 1,700 (Hao et al, 2020) and a meta-analysis with sample sizes frequently in the thousands (Hornsey et al, 2016). In context with our sample size of 79, the significance of our RMSEA value should not be considered. CFI measures how well a model shows correlation compared to a null model with no proposed associations (van Laar & Braeken, 2021). Our value (0.79, Table 4) is below the recommended cutoff of significance (0.96), thus indicating the model shows poor fit (Hu & Bentler, 1999). TLI is very similar to CFI and particularly measurable for small sample sizes, however, our value (0.73, Table 4) similarly falls below the recommended cutoff of significance (0.95) (Schumacker & Lomax, 2004).

The insignificant results of the SEM show the model is not a good fit. This is most likely due to low sample size and poor model design. Various papers postulate different minimum sample size thresholds for SEM; though there is no consensus, opinions generally range from 100—400, which our study falls well below (Wolf et al., 2013). Our model (Figure 1) includes four hypothesized associations. However, our two hypotheses only cover three latent variables; belief in climate change was posited to influence psychological distance but was not considered in our hypotheses. As such, it could have been removed from the model entirely without influencing our acceptance or rejection of our alternative hypotheses. We also included all five of our measured socio-demographic variables as influential items within the SEM. Year of study and housing situation may be interesting items to measure separately however they may not be important in modeling our hypotheses.

The amalgamation of CFA-validated survey items into individual scores of hurricane impact, psychological distance, and behavioural change, too, yielded insignificant results. The correlation analysis (Table 5) does not support either alternative hypothesis.

Our findings that 87.3% of survey respondents were female (Figure 2) align with survey participation trends (Becker, 2022). However, gender was not significantly correlated with any one individual survey item.

Though neither alternative hypothesis was supported, notable statements can be made by observing the raw counts of survey responses. Overall, Dalhousie students feel psychologically closer to climate change after Hurricane Fiona (having either agreed or strongly agreed) in all four dimensions: 54.% feel hypothetically closer, 60.8% physically, 55.7% temporally, and 59.5% socially. Overall, Dalhousie students were not influenced by the impact incurred by Hurricane Fiona to adopt sustainable behaviours: 40.5% strongly disagreed or disagreed with transportation behaviours, 46.8% for consumption, and 59.49% for dietary. Many neither agreed nor disagreed as well: 40.5%, 19.0%, and 27.9%, respectively. Literature reviews show mixed results on the relationship between psychological distance and the adoption of pro-environmental behaviours (Mailella et al, 2020). The propensity to adopt such behaviours is only sometimes reported and often only notioned by some commitment rather than actual adoption (Mailella et al, 2020). Our results indicate that Dalhousie students, even if they have adopted sustainable behaviours since Fiona's landfall, cannot attribute them to the event itself. Some highlighted individual open-ended responses to the survey perpetuate this notion. Several individuals indicated they have adopted sustainable behaviours but specifically mentioned it is not because of the hurricane; the only open-ended responses which directly attribute Hurricane Fiona are mentioned below:

> *"My diet has changed following Hurricane Fiona and I have tried to eat more local food while minimizing my meat intake. There are definitely other events in my life*

that co-occurred with this change but the food lost during Fiona had definitely encouraged me to buy less frozen food."

"I buy more non-perishables, and perishables I know I will eat."

"I often over purchase at the grocery store, but losing a lot of food (from the power outage, the food that was in the fridge) demonstrated that I shouldn't buy in bulk often."

All three responses were directly dietary change; however, none focus on shifting diets to minimize climate change-inducing effects. Rather, all responses highlight food waste due to power outages. Arguably, this is more indicative of climate adaptation (i.e., storm readiness) than it is climate mitigation (i.e., with sustainability in mind). Nonetheless, these responses show a shift in Dalhousie students' perceptions of climate change; some students have begun better preparing for future storms post-Fiona.

Limitations & Next Steps

Several limitations were encountered in this study, which may affect the generalizability and reliability of the findings. Firstly, the length of time the survey was conducted may impact the quality and quantity of data collected. The survey was opened on March 12, 2024 and closed on March 25, 2024, giving only two weeks for data collection. Such a short timeframe may not have allowed for sufficient outreach to potential respondents. As a result, the sample size was significantly lower than our determined sample size of 377 students. A total of 79 responses were received, potentially reducing the representativeness of the data and increasing the risk of sampling bias. An acceptable margin of error used by most researchers typically falls between 4% and 8% at the 95% confidence level (Margin of Error, n.d.). The sample size being, 79 students, represented an 11% margin of error at the 95% confidence level. With fewer data points, the margin of error in estimates of population parameters increases. This means that the study's findings may be less precise and reliable, making it difficult to draw meaningful conclusions or make accurate predictions about the Dalhousie student population. In addition, this short data collection period may not have captured a diverse range of perspectives for individuals who experienced Hurricane Fiona. This can result in a skewed or incomplete understanding of the impact of Hurricane Fiona on the perceptions of psychological distance to climate change and the adoption of sustainable behaviours among Dalhousie students. Finally, the question style, specifically regarding how long a participant was without power due to Hurricane Fiona, was inconsistent with the rest of the question styles under variable b) The impact of Hurricane Fiona. As previously mentioned, the number of days without power was likely insignificant due to the question style used in the survey.

As outlined by the various study limitations, for future research a longer survey timeframe, larger sample size and consistent survey question styles are recommended to yield more representative and accurate results. A larger sample size will ensure various statistical

models fit and provide more accurate results where additional research can examine our three insignificant variables of climate change worry, belief in the anthropogenic nature of climate change, and days of lost power.

Conclusions

The results of this study provided valuable insight on how hurricanes can greatly impact students' perceptions and behaviours related to climate change. The primary results suggest there was a weak but positive correlation between hurricane impact and psychological distance to climate change, and between hurricane impact and adoption of sustainable behaviours in Dalhousie Students. Despite some study limitations around the number of survey sample size and duration, the results further emphasize the importance of understanding perception around climate change and the need to take mitigative action. As such, action through sustainable consumption practices, can help mitigate climate change, thereby reducing the frequency of severe storms and in turn mitigate physical damage and mental duress.

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Appendices

Appendix 1: Recruitment poster

Appendix 2: Recruitment slip

Appendix 3: Emails to Dalhousie's Departments of Marine Biology and Earth and Environmental Science's mailing lists

Hello _____,

We are Earth and Environmental Sciences students currently enrolled in Dr. Caroline Franklin's ENVS 3502 course and are conducting a research project on the influence of Hurricane Fiona on the perceptions of psychological distance to climate change and adoption of sustainable behaviours on Dalhousie undergrads. Our names are Reegan Reid, Layla Cox, Ethan Luty, and Sophie Halminen and we were wondering if our poster with our survey link could be distributed throughout your faculty. It would be greatly appreciated. The survey should take around 10 minutes and all participants will be entered in a draw for a chance to win a $50 Amazon gift card. If there are any questions feel free to reach out to any of the emails listed below. Thank you for your time.

This research has been approved by the Department of Earth and Environmental Sciences.

Sincerely,

Reegan Reid: rg223708@dal.ca
Ethan Luty: ethanluty14@gmail.com
Layla Cox: laylacox1@gmail.com
Sophie Halminen: sophie.halminen@gmail.com

Appendix 4: Survey

This survey is for undergraduate students Layla Cox, Ethan Luty, Reegan Reid, and Sophie Halminen's ENVS3502 "The Campus as a Living Lab" research project.

1) Consent form

By answering the following with "Yes," you indicate you have read the following consent form (template from Dalhousie's Office of Research Service's (ORS) Research Ethics. If you do not consent to the survey, please exit this Google Form.

Project title: Assessing the influence of Hurricane Fiona on Dalhousie Students' perceptions of psychological distance to climate change and adoption of sustainable behaviours.

Lead researcher: Layla Cox (ly270121@dal.ca), Dalhousie University, Department of Environmental Science, for ENVS3502 under Dr. Caroline Franklin (Caroline.Franklin@dal.ca).

Other researchers: Ethan Luty (et202522@dal.ca), Reegan Reid (Rg223708@dal.ca), Sophie Halminen (sophie.halminen@dal.ca).

Funding provided by: All four project researchers (Layla Cox, Ethan Luty, Reegan Reid, and Sophie Halminen).

Introduction: We invite you to take part in a research study being conducted by, Layla Cox (lead researcher) and Ethan Luty, Reegan Reid, and Sophie Halminen (other researchers) who is are undergraduate students at Dalhousie University. This research study is part of the Department of Earth and Environmental Science's ENVS3502 class, "The Campus as a Living Lab." Choosing whether or not to take part in this research is entirely your choice. There will be no impact on you, your studies or employment if you decide not to participate in the research. The information below tells you about what is involved in the research, what you will be asked to do and about any benefit, risk, inconvenience, or discomfort that you might experience. You should discuss any questions you have about this study with Layla Cox. Please ask as many questions as you like. If you have questions later, please contact Layla Cox via email, @ly270121@dal.ca.

Purpose and outline of the research study: This study aims to learn Dalhousie students' experiences during Hurricane Fiona, and how they may correlate to their perceptions of climate change and their potential adoption of sustainable behaviours. We hope to determine if relationships between these variables exist, how strong they are, and provide a conclusion on the effects of the hurricane for Dalhousie's students and staff to read.

Who can take part in the research study: You may participate in this study if you were a Dalhousie University student studying, living, and present in the province of Nova Scotia during Hurricane Fiona's landfall on September 24th, 2022.

What you will be asked to do: If you decide to participate in this research, you will be asked to fill out an online survey via Google Forms about your experience during the hurricane, taking roughly five minutes of your time. You will require a device with an internet connection to do so. At the end of the survey, you will be offered a chance to enter in your email address to enter your name in a random draw for a $50 Amazon gift card reward.

Possible benefits, risks and discomforts: Benefits: Participating in the study might not benefit you, but we might learn things that will benefit others. Risks: The risks associated with this study are minimal; there are no known risks for participating in this research beyond being bored or fatigued; if so, you can terminate your filling-out of the survey at any time.

Incentives: To thank you for your time, the end of the survey offers you the opportunity to enter your name (via an email address) in a random draw for a $50 Amazon gift card. One winner will be selected randomly from the pool of those who entered the email addresses. You are eligible to enter even if you do not complete the survey. You will be contacted via the email address you entered should you be the winner.

How your information will be protected: Your participation in this research (only identifiable by the email address you optionally submit) will be known only to the researchers of this study: Layla Cox, Ethan Luty, Reegan Reid, and Sophie Halminen.

Confidentiality: Information that you provide to us will be kept confidential. Only the researchers of this study (Layla Cox, Ethan Luty, Reegan Reid, and Sophie Halminen) will have access to this information. Our research team has an obligation to keep all research information confidential. Your identifying information (in the form of your optionally added email address) will be securely stored separately from your research information. During the study, all electronic records will be kept secure in an encrypted file on the researcher's password-protected computer. There are no paper records kept for this study. We will describe and share our findings in our research project, which will be made public online on Dalhousie's website at the end of the Winter 2024 semester. We will only report group results and not individual results. This means that you will not be identified in any way in our reports.

Data retention: Once the study is over your email address will be immediately detached from your survey responses. The only use of your email will be as a way to contact you should you win the draw. We do not correlate your email address with any of your survey

responses. Once the draw winner is randomly determined, all other email addresses will be deleted, as will the winner's once they are allocated the gift card. Addresses will be permanently deleted off the researcher's laptop with no possibility of retrieval.

Data repositories: Your responses (unidentifiable to you) will be included in the final research report submitted to the ENVS3502 teaching staff. Raw data will not be included, only summary statistics based on the sample pool's responses. The report will be published on Dalhousie University's website, available for the public to view.

With your permission, the information you provide in this research project will be kept by the researchers for other uses in the future by the research team or other researchers outside of this team, such as future ENVS3502 students. To protect your identity, we will remove personal information that could identify you (your email address) in an effort that anyone who might use your information could not identify you. Even if you don't want your information to be kept for future use you can still participate in this study (by not submitting your email address).

If you decide to Stop participating: You are free to terminate your filling-out of the survey at any time. If you do not submit your survey, your responses will not be included for the research study. After participating in the study, you can decide up to March 20th for your survey answers to be removed from the study. This is only possible should you contact one of the researchers via the email you submitted. After March 20th, we will not be able to identify your survey responses with your email as the draw will be complete and all attached email addresses will be removed.

How to obtain results: Your survey results can be saved by you should you so desire, via Google Forms.

Questions: We are happy to talk with you about any questions or concerns you may have about your participation in this research study. Please contact lead researcher Layla Cox (ly270121@dal.ca), or our other researchers, Ethan Luty (et202522@dal.ca), Reegan Reid (Rg223708@dal.ca), Sophie Halminen (sophie.halminen@dal.ca) at any time with questions, comments, or concerns about the research study.

If you have any ethical concerns about your participation in this research, you may also contact Dr. Caroline Franklin (Caroline.Franklin@dal.ca). This form is not being submitted to the Research Ethics Board, however, if you have any ethical concerns you believe the Board should be informed of, you can contact them: Research Ethics, Dalhousie University at (902) 494-3423, or email: ethics@dal.ca.

2) Qualification for survey

By answering “Yes” to the following, you indicate that you are a current Dalhousie University student, and you were a Dalhousie University student that was living, studying, and present in Nova Scotia during Hurricane Fiona’s landfall on September 24th, 2022.

1) Yes

3) Demographics

What was your age during Hurricane Fiona’s landfall, on September 24th, 2022? Please answer with a positive, whole integer.

1) _____.

What was your year and level of study during Hurricane Fiona’s landfall on September 24th 2022? If you weren't taking a mix of differently leveled courses, please answer with the year of study you most identified with.

1) First year undergraduate
2) Second year undergraduate
3) Third year undergraduate
4) Fourth year undergraduate
5) Fifth or greater year undergraduate
5) Masters student
6) PhD student
7) Post-doctorate student

What gender do you most identify with?

1) Male
2) Female
3) If you do not identify as male or female, please select this option and write in your current gender identification in the following question

If you do not identify as male or female, please answer this question with your current gender identification. If you do not need to complete this question, please do not answer. _____.

During Hurricane Fiona’s landfall on September 24th, 2022, what Nova Scotia county were you *physically in*? For example, if your family home is in Digby, but you were present in Halifax, please answer with “Halifax.”

1) Halifax 2) Annapolis
3) Antigonish 4) Cape Breton
5) Colechester 6) Cumberland

7) Digby 8) Guysborough
9) Hants 10) Inverness
11) Kings 12) Lunenburg
13) Pictou 14) Queens
15) Richmond 16) Shelburne
17) Victoria 18) Yarmouth

Which of the following housing situations do you most identify having lived in during Hurricane Fiona's landfall on Septemver 24th, 2022?

1) Dalhousie residence (for example, Howe Hall, Risley Hall, etc.)
2) A "student house": a house similar to a family-style home but with one or multiple units where most units are populated by secondary school students
3) Apartment building of less than four floors
4) Apartment building of more than four floors
5) Family-style home
6) Other

As you perceive, is Hurricane Fiona the *most severe* hurricane you have experienced? This is based on your own perception, not any scientific scale.
_____.

4) Belief in climate change

In my lifetime, the climate in Nova Scotia has _____.

1) Not changed at all
2) Changed slightly
3) Changed moderately
4) Changed significantly
5) Changed drastically

In the past hundred years, the climate in Nova Scotia has _____.

1) Not changed at all
2) Changed slightly
3) Changed moderately
4) Changed significantly
5) Changed drastically

Within my lifetime, the climate in Nova Scotia will _____.

1) Not changed at all
2) Changed slightly

3) Changed moderately
4) Changed significantly
5) Changed drastically

I am _____ about climate change.
1) Unworried
2) Slightly worried
3) Moderately worried
4) Significantly worried
5) Drastically worried

I believe that climate change is caused by _____.
1) Completely natural processes
2) Mostly natural process and some human processes
3) Equally natural processes and human processes
4) Mostly human processes and some natural processes
5) Completely human processes

5) Impact of Hurricane Fiona

Around how many days did the residence you were *physically in* during Hurricane Fiona's landfall lose power, including the actual day of landfall? Please answer with a positive whole integer, with no spaces or punctuation.
1) _____

Indicate your degree of agreement with the following statement: Before landfall, *financially*, I was worried about suffering from *days of lost work* caused by Hurricane Fiona.
1) Strongly disagree
2) Disagree
3) Neither disagree nor agree
4) Agree
5) Strongly agree

Indicate your degree of agreement with the following statement: Before landfall, *financially*, I was worried about p*otential damages to my possessions and/or property* caused by Hurricane Fiona.
1) Strongly disagree
2) Disagree
3) Neither disagree nor agree

4) Agree
5) Strongly agree

Indicate your degree of agreement with the following statement: Before landfall, *mentally*, I was worried about suffering from *lost days of recreation and/or routine* (ex. exercise, socialization, closeness to nature) caused by Hurricane Fiona.

1) Strongly disagree
2) Disagree
3) Neither disagree nor agree
4) Agree
5) Strongly agree

Indicate your degree of agreement with the following statement: Before landfall, *physically*, I was worried about my own *safety and/or security* caused by Hurricane Fiona.

1) Strongly disagree
2) Disagree
3) Neither disagree nor agree
4) Agree
5) Strongly agree

Indicate your degree of agreement with the following statement: I live with a pre-existing mental health condition, and experienced heightened symptoms (such as anxiety, depression, or PTSD) leading up to OR during the landfall of Hurricane Fiona.

1) Strongly disagree
2) Disagree
3) Neither disagree nor agree
4) Agree
5) Strongly agree

6) Perceptions of psychological distance of climate change post-Fiona

Indicate your degree of agreement with the following statement: I feel less *hypothetically* distant to climate change *after* experiencing Hurricane Fiona. That is, I now feel that the effects of climate change are more certain to be happening to me.

1) Strongly disagree
2) Disagree
3) Neither disagree nor agree
4) Agree
5) Strongly agree

Indicate your degree of agreement with the following statement: I feel less *physically* distant to climate change *after* experiencing Hurricane Fiona. That is, I now feel that the effects of climate change are happening closer to me.

1) Strongly disagree
2) Disagree
3) Neither disagree nor agree
4) Agree
5) Strongly agree

Indicate your degree of agreement with the following statement: I feel less *temporally* distant to climate change *after* experiencing Hurricane Fiona. That is, I now feel that the effects of climate change are happening sooner in time.

1) Strongly disagree
2) Disagree
3) Neither disagree nor agree
4) Agree
5) Strongly agree

Based on this survey's previous questions, how *intense* do you perceive Hurricane Fiona to have been?

1) Not intense at all
2) Slightly intense
3) Moderately intense
4) Very intense
5) Extremely intense

7) Behavioural changes

Indicate your degree of agreement with the following statement: The impact I or others incurred from hurricane Fiona influenced my *transportation* behaviours to become more sustainable. Examples include, but are not limited to, reducing car travel or increasing public transit use.

1) Strongly disagree
2) Disagree
3) Neither disagree nor agree
4) Agree
5) Strongly agree

Indicate your degree of agreement with the following statement: The impact I or others incurred from hurricane Fiona influenced my *consumption* behaviours to become more sustainable. Examples include, but are not limited to, reducing purchase of international goods or using more reusable goods.

1) Strongly disagree
2) Disagree
3) Neither disagree nor agree
4) Agree
5) Strongly agree

Indicate your degree of agreement with the following statement: The impact I or others incurred from hurricane Fiona influenced my *dietary* behaviours to become more sustainable. Examples include, but are not limited to reducing meat consumption or eating more local foods.

1) Strongly disagree
2) Disagree
3) Neither disagree nor agree
4) Agree
5) Strongly agree

If you agreed with any of the previous three questions, and wish to elaborate on what specific behviours of yours you have changed, please do so here. This is an open-ended question, please share any of your thoughts.

_____.

Do you feel Hurricane Fiona's impact in Nova Scotia is 'enough' to cause an actual, tangible shift in Nova Scotians' behaviours to become more sustainable? This is an open-ended question, please share any of your thoughts.

_____.

8) Optional email address submission for $50 Amazon gift card

Our researchers are offering you a chance in a randomized draw for a **$50 Amazon gift card** in the pool of all survey-takers. If you would like to enter, please leave your email address which we could contact you, should you win, below. If you would not like to enter, leave this question blank. Details about the draw can be found at the first page of this survey in the Consent Form. We will not contact you if you do not win, and your email will be permanently deleted from our data immediately following the draw. Please enter your email below.

_____.