Public perceptions of climate change adaptation in Singapore dealing with forecasted sea level rise

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\textbf{ABSTRACT}

Perceptions of the populace play a central and decisive role in advancing pro-environmental policies. To study attitudes and perceptions towards environmental measures, we apply several items of New Ecological Paradigm (NEP) and Value-Belief-Norm (VBN) theories to cross-examine the public perceptions of climate change in the urban city-state of Singapore through analysis of quantitative questionnaires and qualitative semi-structured interviews. The perceptions were explored about ecological orientation (two dimensions of NEP: level of concern, self-reported knowledge) and environmental behavior (two dimensions of VBN: acceptance and support of national adaptation measures, confidence in adaptation). There is a moderate to high concern for climate change, in general, and sea level rise and flooding, in particular, and the concern is expected to increase in the future. Individuals who indicated a higher level of concern are likely to be more accepting and supportive of climate change measures. Also, while the majority of the populace are amenable to legislative measures from the government, such as enacting pro-environmental laws and more are agreeable to accepting cuts on living standards, as opposed to paying more in prices and taxes. Ecological orientation does not translate directly into environmental behavior, highlighting the gulf between perception and behavior in Singapore.

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Highlights

- Perceptions of the populace play a decisive role in advancing pro-environmental policies.
- There is major and increasing concern in Singapore regarding sea level rise under climate change.
- The levels of education and gender cause divergences in climate change perceptions and attitudes.
- Ecological orientation does not translate directly into environmental behavior, highlighting the gulf between perception and behavior.

Introduction

Climate change is one of the most pressing global challenges facing humankind at present. The continued warming of Earth’s climate system has been predicted to have far-reaching consequences, across different regions of the world. Because of mounting evidence of anthropogenic influences on the climate system, the Kyoto Protocol came into force in 2005 in a bid to reduce the effect of human activities on the climate system. However, the recent Intergovernmental Panel on Climate Change assessment report (IPCC 2013) highlighted that the phenomenon is expected to go on unabated unless there are major revisions to international climate policies. Climate change impacts are of particular significance in densely populated urban centers. Widely described as the global engines of economic growth and innovation, cities present a wealth of opportunities to its inhabitants and connect countries to one another through prosperous commercial relationships. In turn, this intensifies migrations from rural landscapes to
increasingly heavily populated city centers, as evidenced by the most recent World Cities Report that concluded that presently more than half of the world’s population lives in cities with the proportion set to rise further (United Nations Habitat 2016). Crucially, the rapid expansion of households, infrastructures, and industries embedded in urban areas translates not solely to facilitating economic development but also to a higher severity and risk of climate-associated impacts (Wardekker et al. 2010). The most critical effects of climate change on cities include sea level rise, extreme weather events, health risks, disruptions to energy use, and threats to water resources (Hunt and Watkiss 2011). These factors point to an exigent need for cities to develop adaptive measures to the imminent risks of climate change.

With growing recognition of the importance in adapting and mitigating climate change at a city level, organizations have urge city leaders to work together for a common goal. The UN-Habitat’s Cities and Climate Change Initiative (CCCI) and organizations such as the C40 Cities Climate Leadership Group have been formed with the aim to link global cities to tackle climate change through information-sharing and collaborative urban actions. Hence, it becomes increasingly clear that cities have a decisive role to play in the mitigation and adaptation to climate change.

**Climate change and public policy**

The dilemma for policymakers and the public is to relate and react appropriately to the uncertainties of climate change (Yousefpour and Hanewinkel 2016). Apart from the interacting uncertainties, the reasons behind the debates on climate change between policy makers, scientists, the general public, and media are manifold. Many debates are motivated on grounds of strategic and logical rationales, but others stem from psychological and cultural contexts that might more strongly influence people’s mindsets towards the phenomenon. All in all, the mentioned influential components coalesce and are presented in the form of viewpoints and perceptions of the populace towards climate change (Lewandowsky and Oberauer 2016; Weber 2010). The importance of incorporating public perceptions into policy-making is not to be under-stated.

Adapting to an uncertain and evolving future is challenging, thereby for public policies to remain relevant they must continuously keep up and incorporate new information made available by the scientific community. As a deeply complex and multifaceted issue, climate change is a topic not easily grasped by non-scientists and the greater public (Füngfeld 2010; Ungar 2000). Many times, scientific findings are dismissed when the population is either misinformed or the presented facts are antagonistic to the individual’s perceptions of the world, religion, or political ideology, described as motivated identity-protective cognition by Lewandowsky and Oberauer (2016). Thus, in the formulation of climate-related adaptation policies, taking into account public values and views are pivotal for several reasons:

First, a certain degree of consent from those who would be affected is required for successful implementation of policies (Lorenzoni and Pidgeon 2006). Without public acceptance before implementation, the policy may be neglected or opposed by the electorate. Particularly policies that require the active support and participation of the publication are needed. Second, apart from public acceptance, integrating a diverse set of
perspectives is indispensable for creating inclusive policies which are relevant to local stakeholders who are directly impacted by them. Depending on the peculiarities of a city in terms of the vulnerabilities of people (e.g. health, properties), infrastructure, and ecosystems, specific aspects of climate change might be relevant (Whatmore and Landström 2011). Third, public views can be a driving force for political actions to address specific climate-related risks. In direct relation to climate polices, Leiserowitz (2006) states that “Public risk perceptions can fundamentally compel or constrain political, economic, and social action to address particular risks.” Personal beliefs and viewpoints influence the support for policies, for instance, policies that propose higher taxes for climate change adaption or that imply lifestyle changes such as reducing household energy usage. When sufficiently commonplace, changes in overall consumer behavior can provide a clear indication of citizens’ preferences and concerns to the government and can be a source of motivation for climate change adaptation measures (Nordgren et al. 2016; Stern et al. 1999).

**Measuring environmental perceptions**

As posited by Slovic (1987), public perceptions are influenced by a wide array of factors such as personal experience, imagery, emotion, worldviews, psychological, and social aspects of each individual. Accordingly, the measurement of perceptions of environmental issues has been extensively studied and scholars have proposed numerous frameworks which attempt to capture the diverse and multidimensional impressions of the populace. From the area of environmental sociology, The New Environmental Paradigm (NEP) scale measures five facets of pro-environmental orientation: reality of limits to growth, anti-anthropocentrism, the fragility of nature’s balance, rejection of exemptionalism, and the possibility of an ecocrisis (Dunlap et al. 2000). In theory, the NEP scale is related to Schwartz’s (1999) harmony-mastery cultural value dimension which posits that societies regulate anthropogenic activities either by preserving the natural environment (harmony values, or by exploiting and altering the world (mastery values) (Hawcroft and Milfont 2010).

Stern et al. (1999) presented the value-belief-norm (VBN) theory that focuses on individuals’ acceptance and preference for environmental actions. Causing changes in behavior and the role of supporters are emphasized in their study. Supporters are, here, differentiated from the activists by their tempered down level of action when demonstrating their endorsement for pro-environmental policies. Moreover, looking at environmental attitudes across different countries, the International Social Survey Program (ISSP) administers a survey in member countries throughout the world each year with a different module of focus each time. ISSP's environmental module looks at attitudes towards environmental protection, individual’s behavior as well as support for governmental measures. Other commonly cited international surveys on environmental attitudes include the World Values Survey (WVS) and the European Values Survey (EVS), and as shown by Franzen and Vogl (2013), the three surveys can culminate into distinct but comparable results.
Climate change impacts on Singapore

Singapore is a small city-state of 716 km² with one of the highest population densities in the world counting 7829 people per km². Global projections of climate change impacts show that the main risks faced by low-lying coastal cities such as Singapore are mean sea-level rise and more extreme rainfall events (IPCC 2013). The majority of Singapore’s land area lies less than 15 m above mean sea level and about 30% of Singapore is within a mere 5 m above mean sea level. The mean sea level in the straits of Singapore surrounding the island state has been observed to rise steadily, with an annual increase of 1.2–1.7 mm between 1975 and 2009 (Tkalich et al. 2013). Annual rainfalls have been on an upward trend over the past 30 years with an average increase of 116 mm per decade since 1980 (MSS 2015). During extended periods of heavy rainfall, sporadic flooding events have occurred in low-lying areas of the island. Paradoxically, however, water scarcity is a key issue as precipitation patterns show considerable variability between wetter and drier months (MSS 2015) and periods of drought in recent years have negatively affected Singapore’s water supply. Apart from changes in the water cycles, the surface temperature in Singapore has risen at a rate of 0.25°C per decade in the past 60 years which is approximately double the global average of 0.12°C per decade during the same period and is projected to rise further (MSS 2015).

Literature review

Akerlof and Maibaach (2014) conducted a statewide survey about the sea levels off of Maryland’s shorelines raising more than a global average (one foot in the last century). They found that more than half of Marylanders (55%) perceive protecting coastal areas as a high or very high priority for the state’s General Assembly and the Governor by e.g. changing regulations on zoning laws and set-back distances for building and tax incentives to property owners to take protective actions (55%), and using government funds to buy natural areas as buffers against rising waters and storms (55%). Another survey in USA State of New Jersey by Burger et al. (2016) showed a decline in interest and concern about climate change and sea level rise between 2012 and 2014 mainly because of experiencing the super storm “Sandy” at 2012. Thomas (2013) investigated the public and experts’ understanding of sea level rise in United Kingdom and found that there is low public salience of some of the key drivers of sea-level change and its indirect impacts compared to experts. Studies on adaptation to deal with the sea level rise show widely divergent policies and measures e.g. among European countries (Tol et al., 2008) and demand large investments on dike constructions and maintenance, e.g. global cost of US$12–71 billion in 2100 (Hinkel et al. 2014). Barnett et al. (2013) found public-view federal government as the responsible entity to bear the costs and that there are barriers to adaptation in climate change adaptation in Australia including governance, policy, uncertainty, resources, and psychosocial factors. This study as well asks about public view on governmental adaptation strategies. Willingness of people, especially young teenagers as the leading generation for future development, has been of recent interest for research. Kuthe et al. (2019) found that teenagers who are not concerned about climate change believe that climate change will happen only in the future.
Study goals

The perceptions towards climate change can have critical ramifications for the design, implementation, and outcomes of climate adaptation policies. Hence, we conducted a mixed methods study, including both quantitative and qualitative approaches, on the local perceptions of climate change in Singapore. The quantitative part referred to four main "lenses": degree of concern for climate change, self-assessment of knowledge on climate change and the adaptation measures, acceptance and support for adaptation actions, and level of confidence in these actions. These four dimensions have been adapted to encompass various important aspects of perceptions towards the topic of climate change. Moreover, respondents' ecological worldviews and self-reported environmentally-responsible behavior were gathered in the quantitative part, representing how the theories of new ecological paradigm and value-belief-norm. Moreover, qualitative interviews were conducted with selected individuals who had differing views on climate change to explore the reasons behind the perceptions and attitudes that were measured through the quantitative questions. Overall, this study aims to shed light on the public perceptions concerning climate change in Singapore as well as on the reasons for those viewpoints.

Methods

Questionnaire design and interview

The questionnaire was developed according to the main aims of the study, in cooperation with experts from the field and professionals of public survey, and tested with low number of participants, citizens registered and residing in Singapore. Feedbacks from test group, especially regarding language, format, sequence, and clarity of queries, were regarded in the final version of questionnaire and the design of interview questions. The questionnaire was sent online by email contacts received anonymously from public registration. The questionnaire was distributed online through Google Forms in Singapore, targeted at respondents from a variety of age-groups and backgrounds across the country. The online questionnaire contained a series of questions where respondents could indicate their agreement or disagreement with the presented statements on a 5-point Likert scale (Vagias 2006; for example, ranging from strongly agree to strongly disagree). To keep respondents attentive, the Likert scale items were interspersed with dichotomous questions, multiple-choice questions, matrix questions and a final optional open-ended question where respondents can input additional comments (See Appendix A). By asking limited number of precise and related questions, response to all items (a total of 44 items taking approximately 5–10 min to complete) was made mandatory to avoid missing data and overlooking important queries by respondents. Respondents had the opportunity to reject answering questions and be excluded from further analysis. Both the quantitative online questionnaire and qualitative semi-structured interviews were completed over the month of December 2016. Finally, we received 134 fully answered questionnaires for the analysis and interviewed 10 respondents afterwards. Interviewees were selected based on their general concerns about climate change (to represent a range of concerns) and availability of respondents to be interviewed. Finally,
we could safeguard at least ten responses to each individual question to make use of the data in statistical analysis.

**Perceptions on climate change**

To study perceptions on climate change, key questions were designed to look at responses in the four dimensions of (1) level of concern for climate change, (2) self-assessment of knowledge on climate change adaptation measures, (3) acceptance and support for the measures, and (4) level of confidence in the measures. The questions were adapted from a number of sources, and several were formulated specifically for this study. For the analysis, a sum score was calculated for each dimension.

For the dimension **level of concern for climate change**, respondents were asked on a scale from 1 (not concerned at all) to 5 (extremely concerned): “In general, how concerned are you about climate change?” and on a scale from 1 (not important at all) to 5 (extremely important): “How important do you think it is for Singapore to adapt to climate change?” Moreover, to examine temporal shifts in opinions towards the climate change, respondents were queried on a scale from 1 (not at all affected) to 5 (extremely affected) how much they thought climate change has affected them and the nation in the past and present and how much this will presumably be the case in the future: “How much do you think climate change has affected and will affect you (alternate question: Singapore) in the past and currently (alternate question: in the future)?”

Furthermore, specific threats of climate change to Singapore (flooding and erosion of low lying areas due to rising sea levels, loss of natural habitats and decline in variety of plants and animals, negative impacts on human health through heat stress and haze, more frequent and severe weather such as heavy rainfall and dry spells, shortage and depletion of water supply, disruption to food supply and price hikes) were listed and respondents indicated their level of concern about each threat on a scale from 1 (not critical at all) to 5 (extremely critical).

Within the second dimension **self-assessment of knowledge on climate change adaptation measures** respondents rated on a scale from 1 (known nothing at all) to 5 (know a great deal): “In your own opinion, how much do you know about the causes of climate change?” and “In your own opinion, how much do you know about the solutions to cope with climate change?” The questions were adapted from International Social Survey Program’s Environment III Module (ISSP 2010), which has been conducted in 32 ISSP member countries to measure environmental knowledge. In addition, they were asked if they knew about the National Climate Change Strategy or Climate Action Plan or any projects relating to adapting the nation to future climatic shifts, with the answer options yes, no, and maybe. Respondents were also asked if they would like to receive more information on how Singapore is adapting to climate change (with the answer options yes, no, and maybe).

For **acceptance and support of climate change measures**, three questions from the “Willingness to Sacrifice” dimension of Stern’s Value-Belief-Norm Theory (Stern et al. 1999) was used to gauge respondents acceptance and support for environmental policy. Respondents were asked to indicate their degree of agreement, on a scale from 1 (strongly disagree) to 5 (strongly agree), with the statements: “I would be willing to pay
much higher taxes in order to protect the environment,” “I would be willing to accept cuts in my standard of living to protect the environment,” and “I would be willing to pay much higher prices in order to protect the environment.” Moreover, to indicate the perceived main authority responsible for taking action on climate change in Singapore, respondents were given the options of individuals, government, businesses, non-governmental organizations, and other.

Lastly, for assessing the dimension level of confidence in measures, respondents were asked to what degree they agreed with the statements: “Singapore has the ability to adapt to climate change,” “Singapore is well-prepared to cope with climate change,” and “The government will take care of the climate change issue.” The scale ranged from 1 (strongly disagree) to 5 (strongly agree).

**Ecological orientation**

To measure ecological orientation by asking a limited number of related questions, seven items were adapted from the 15-item New Ecological Paradigm (NEP) developed by Dunlap et al. (2000) to specifically reveal respondents perception on climate change. Respondents were asked to indicate their level of agreement with the statements on a 5-point Likert scale and the answers to all seven items were summed for an overall ecological orientation score for each respondent. Similar to the original bipolar format of the NEP scale, statements in which agreement indicates a pro-ecological worldview were alternated with statements whereby disagreement indicate a pro-ecological worldview: “The earth is like a spaceship with very limited room and resources,” “The balance of nature is strong enough to cope with the impacts of modern industrial nations,” “Humans have the right to modify the natural environment to suit their needs,” “The so-called ecological crisis facing humankind has been greatly exaggerated,” “Humans are negatively impacting the environment,” “If things continue on their present course, we will soon experience major ecological issues,” and “Despite our special abilities humans are still subjects to the laws of nature.” Ecological orientation was treated as a continuous variable with a minimum of 7 (least ecologically oriented) to a maximum score of 35 (most ecologically oriented).

**Environmental behavior**

Environmental behavior was assessed through a five-item scale adapted from the National Climate Change Perception Survey (NCCS 2012). The items addressed the participation in environmental behavior such as “How often do you choose appliances with energy and water efficient labels?,” “How often do you turn off electrical mains when not in use?,” “How often do you use public transport whenever possible?,” “How often do you avoid food wastage?,” and “How often do you reduce, reuse, recycle to minimize waste?” Responses on the scale ranged from 1 (never) to 5 (always). Assuming that the behavioral responses are quite different, the responses to all five items were summed to provide an overall environmental behavior score for each respondent. We tested this by applying a Principal Component Analysis (PCA) showing that at least five factors are necessary to reach a total cumulative variance of over 50% (see Table 1). The possible
scores for environmental behavior ranged between 5 (no environmental action) and 25 (most environmental action).

**Demographic questions**

In accordance with the goals of this study and the sample design, six questions were demographic in nature, pertaining to the respondents’ gender, race, age range, educational level, the primary area of employment, and sources of information on climate change. The demographic questions were placed last as it has been shown that respondents were more likely to reveal private information if other questions have been answered first (Dillman 2000).

**Interviews**

Qualitative techniques have been increasingly deployed in conjunction with quantitative methods to answer questions with mixed methods (Johnson and Onwuegbuzie 2004). Within the social sciences, semi-structured interviews have been shown to be useful in exploring individuals’ perceptions and processes relating to multi-faceted themes (Anderson 2010; Holmes and Clarke 2008). For this study, findings of the online questionnaire were complemented by qualitative interviews with individuals who have been selected for their differing perspectives on climate change (regarding their perceptions, ecological orientation, and environmental behaviors) and demographic backgrounds (i.e. education level, age groups, gender, and race). The questions for the interview were designed to engage the interviewees in a conversation about climate change in Singapore, specifically to uncover latent rationalizations behind positive or negative perceptions of climate change and the national climate policy. The guiding questions used in the semi-structured interviews can be found in Appendix A. Finally, the findings of this study encompass a wide range of responses, disregarding the majority or minority of responses.

**Data analysis**

Each dimension of climate change perception was analyzed in relation to the other dimensions, ecological orientation, environmental behavior, and in relation to the demographic groups (education level, age groups, gender, and race). If a Levene’s test indicated that the assumption of equality of variances was fulfilled (Levene 1960), an analysis of variance (ANOVA) was performed to determine if there were statistically significant differences between the responses of the demographic groups. In the case of statistically significant differences, post-hoc tests were conducted with the Tukey’s honest significant difference test (HSD) to further investigate which specific demographic

| Factorial vectors of PCA | F1  | F2  | F3  | F4  | F5  |
|--------------------------|-----|-----|-----|-----|-----|
| Eigenvalue               | 2.021| 1.762| 1.548| 1.414| 1.242|
| Variability (%)          | 13.470| 11.749| 10.323| 9.424| 8.282|
| Cumulative variability % | 13.470| 25.219| 35.542| 44.966| 53.248|
groups statistically differed from each other (Tukey 1949). In the event that the Levene’s test showed that the assumption of equality of variances was not fulfilled, a Welch’s ANOVA was performed. In these cases, post-hoc testing was carried out with the Games-Howell tests (Games and Howell 1976; Welch 1947).

To examine the internal consistency for the ecological orientation and environmental behavior scales, Cronbach’s alpha was computed (Cronbach 1951) as the mostly applied coefficient (Flake et al., 2017). In addition, the Shapiro-Wilk test was used to test both scales for normality distribution (Shapiro and Wilk 1965). In addition, the Pearson correlation coefficient was calculated to assess the association between the scales of ecological orientation and environmental behavior. Correlation analysis is applied to show dependency of behaviors to concerns and demographic variables.

The semi-structured interviews were recorded by hand. At the end of each interview, the gathered data was checked with the interviewee for respondent validation. The data from each verified interview was later transcribed verbatim into electronic versions. During the coding stage, an iterative approach was used for developing and assigning the categories and themes (Fossey et al. 2002). Based on grounded theory, extracts relevant to the study themes were first assigned codes (Strauss and Corbin 1988). Next, the codes were sorted and sub categorized in accordance to patterns and their connections to the major themes. The relationships between the subcategories were then explored and refined to develop generalizations and key themes (Richards 2014). In illustrating these key themes, any direct verbatim quotes used are anonymized to protect interviewee confidentiality.

Results

Characteristics of respondents

A sample size of 134 individuals residing in Singapore responded to the online questionnaire. 59.7% of the respondents were female and 40.3% were male. The ethnic distribution of the respondents was as follows: 83.6% Chinese, 9.7% Malay, 3% Indian, 1.5% Eurasian, and 2.2% Other (See Appendix B). More than half (56%) of the respondents were aged between 25 and 34 years, with 16.0% below 25 years, and 28.0% above 34 years. All of the respondents had completed a minimum of secondary school education, with the majority (59.7%) having a Bachelor’s degree. A total of ten interviews were conducted. Each interview was conducted individually with the interviewee and lasted approximately 30 min. Of the ten interviewees, six identified themselves as more ecologically oriented while the remaining four perceived themselves as less environmentally concerned (the demographics of interviewees are presented in Appendix B). Overall, the sample is a good representation of public in Singapore (e.g. Ethnicity groups, gender, age), however, with a more focused on highly educated public (59.7% with BSc degree).

Questionnaire respondents’ perceptions of climate change

Degree of concern about climate change

The responses revealed a moderate to high level of concern for climate change. More than 70% of the respondents indicated that they were moderately or extremely
concerned about climate change and over 80% believed that it was moderately or extremely important for Singapore to adapt to the phenomenon. The majority of the respondents perceived that climate change has a slight to moderate effect on their personal lives in the past and presently (85%) while a small group considered climate change to have had no effect (7%). For the future, the bulk of the respondents (80%) posited that climate change effects would be more serious and have a moderate to extreme effect on their personal lives. As illustrated in Figure 1, a similar pattern emerged for respondents' views of climate change effects on Singapore. Most judged that the nation was slightly and moderately affected by climate change in the past and presently (80%) while for the future the prevailing opinion was that Singapore would be moderately or extremely affected. In addition, there appears to be an increment in the number of respondents reporting uncertainty for future climate change effects on their personal lives (1% to 9%) and Singapore as a nation (1% to 4%). From the different impacts of climate change, shortage and depletion of water supply was perceived to be the most critical impact (score = 424), followed by disruptions to food supply and price hikes (score = 415), and negative impacts to human health (score = 414). On the whole, the respondents see the six presented climate change impacts to be of moderate to high risk. A slight percentage of respondents (2%) regarded flooding and loss of biodiversity to be a non-critical impact of climate change (See Appendix C).
We investigated if there were differences between the levels of education and gender with regard to the level of concern about climate change (Table 2). For the item of "How important do you think it is for Singapore to adapt to climate change?" a Welch’s test suggested a statistically significant difference between the respondents from different education levels, $F(3,130) = 2.98$, $p = .049$. Post-hoc comparisons using the Games-Howell test (Table 3) were conducted to determine which pairs of education levels significantly differed. The results indicated that respondents with a Bachelor’s degree ranked the importance of adapting Singapore to climate change significantly higher ($p = .049$) than respondents with completed post-secondary education ($n = 33$, $M = 4.09$, $SD = 0.77$). In addition, the post-graduate group ranked the importance of adaptation for the nation lowest.

Concerning gender, the results from a one-way ANOVA showed that male respondents ($n = 54$, $M = 4.52$, $SD = 0.80$) ranked the importance of adapting Singapore to climate change higher as compared to female respondents ($n = 80$, $M = 4.18$, $SD = 0.89$), $F(1,132) = 5.40$, $p = .020$. No significant differences were found between the different age groups and races with regard to their level of concern to climate change.

**Self-assessment of knowledge**

Nearly half of the respondents reported that they did not know of any measures Singapore has taken to adapt to climate change (48%) while a third acknowledged that
they were not sure. A larger percentage have not heard of the national climate change strategy and climate action plan (69%). In contrast, most of the respondents (85% and 71%, respectively) gauged themselves to have some level of knowledge of the general causes and solutions to climate change problems with a small group having a deep understanding (5% and 4%, respectively). Based on the results from a one-way ANOVA, there were no significant differences between the different age groups in their self-reported knowledge for the causes, $F(5,128) = 2.06, p = .07$, and solutions, $F(5,128) = 2.02, p = .08$, of climate change. Post-hoc comparisons using Tukey’s HSD revealed the main difference to stem from the age groups of 25–34 years and 35–44 years. Respondents in the 35–44 years age group reported lower knowledge of climate change as compared to the other age groups. For education levels, gender, and race, there were no statistically significant differences in their self-assessment of climate change knowledge. The most common source for obtaining information on climate change was the internet (90.3%), followed by the television (55.2%), and the newspapers (48.5%).

| Age group (I) | Age group (J) | Mean diff. (I-J) | Std. Error | Significance | Lower bound | Upper bound |
|---------------|---------------|------------------|------------|--------------|-------------|-------------|
| 35–44         | 0–18          | −0.548           | 0.325      | 0.544        | −1.49       | 0.39        |
|               | 19–24         | −0.586           | 0.276      | 0.282        | −1.38       | 0.21        |
| A             | 25–34         | −0.394*          | 0.193      | 0.030*       | −1.15       | −0.04       |
|               | 45–54         | −0.271           | 0.091      | 0.67         | −0.49       | 0.24        |
|               | 55–64         | −0.381           | 0.071      | 0.37         | −0.75       | 0.01        |
| 35–44         | 0–18          | −0.554           | 0.347      | 0.679        | −1.43       | 0.25        |
|               | 19–24         | −0.505           | 0.315      | 0.49         | −1.42       | 0.08        |
| B             | 25–34         | −0.682**         | 0.220      | 0.029*       | −1.32       | −0.04       |
|               | 45–54         | −0.338           | 0.332      | 0.912        | −1.30       | 0.62        |
|               | 55–64         | −0.429           | 0.413      | 0.905        | −1.62       | 0.77        |
Acceptance and support for adaptation measures

In terms of taking action on climate change in Singapore, the majority (48%) stated that the individuals have the largest role to play and 36% considered the government to be mainly responsible. Under Stern’s willingness-to-sacrifice facet, the respondents were divided when asked for their endorsement of paying much higher taxes and prices to protect the environment: 36% and 23% disagreed, 40% and 44% expressed neutrality, and 24% and 33% agreed. In contrast, a larger proportion (54%) agreed to cuts in their standards of living and with 29% taking a neutral stance (see Figure 2). Support for environmental policies was even clearer, with 81% and 93% having the opinion that the government should establish environmental protection clauses in the legislation for environmental protection even if it interferes with the freedom of people and businesses. From one-way ANOVAs, insignificant differences were found for the level of acceptance and support between the demographic groups.

Confidence in the adaptation measures

More than two-thirds of the responses (69%) deemed that Singapore has the capabilities to adapt to climate change. There was lesser confidence in the government handling the climate change issue satisfactorily, with 54% signaling disagreement or insecurity. With regards to preparedness to cope with the impacts of climate change, 65% disagreed or were unsure that the nation is ready to cope. A one-way ANOVA revealed significant differences in the responses of different age groups, $F(5,128) = 2.56$, $p = .03$, and gender, $F(1,132) = 5.62$, $p = .02$, to the preparedness of Singapore to climate change. Post-hoc comparisons using Tukey’s HSD, however, indicated statistically insignificant differences between the age groups. The findings closest to significance ($p = .09$) were between respondents aged between 25 and 24 years ($n = 75$, $M = 2.73$, $SD = 0.94$) and respondents aged between 45 and 54 years ($n = 11$, $M = 3.55$, $SD = 0.82$), where younger respondents perceived Singapore to be less prepared to cope with climate change compared with older respondents. Concerning gender, male respondents ($n = 54$, $M = 2.67$, $SD = 0.93$) ranked the preparedness of Singapore to climate change lower than female respondents ($n = 80$, $M = 3.06$, $SD = 0.96$), $F(1,132) = 5.62$, $p = .02$. Additionally, statistically insignificant results from an ANOVA suggested that male respondents ($n = 54$, $M = 2.70$, $SD = 1.14$) reported less confidence in the government to take care of the climate-change issue as compared to females ($n = 80$, $M = 3.10$, $SD = 1.14$), $F(1,132) = 3.88$, $p = .05$.

Ecological orientation and environmental behavior

The subscale of environmental orientation comprised of seven items had a poor but acceptable internal consistency of $\alpha = 0.66$. This low consistency with $\alpha$ equal or below 0.6 is reported as a somewhat common result in literature, however, the average is 0.78, and ranges from 0.17 to 0.97 (Flake et al. 2017). The respondents were moderately to extremely ecologically-oriented with scores ranging from 18 to 35 ($M = 26.70$, $SD = 3.96$). For the 5-item subscale of environmental behavior, the internal consistency was good, $\alpha = 0.71$. The respondents reported environmental behavior scores from 12 to
25 (M = 19.32, SD = 3.08). From the Shapiro-Wilks test of normality, the distribution of scores for ecological orientation was considered to be statistically normal (p = .054, skewness = 0.159, kurtosis = -0.539) and examination of the histogram and Q-Q plot further suggests normality. On the other hand, scores for environmental behavior suggested a non-normal distribution (p = .008, skewness = -0.049, kurtosis = -0.547).

Pearson product-moment correlation showed that ecological orientation and environmental behavior had a weak, positive correlation which was statistically significant (r = 0.222, n = 134, p = .010). The distribution of ecological orientation and environmental behavior scored are summed up in Appendix D.

A one-way ANOVA showed there were no significant differences amongst the demographic groups concerning environmental behavior. Between the different levels of education, statistically insignificant differences were found for environmental behavior, $F(3,130) = 2.58, p = .06$. Similarly, no statistically significant differences were found for the different demographic groups (age-groups, education levels, gender, and race) and their ecological orientation scores.

**Correlations among dimensions**

For the four dimensions of perceptions towards climate change, Pearson product-moment correlation (Table 5) revealed positive correlations between level of concern and self-reported knowledge as well as between level of concern and acceptance for climate change measures ($r = 0.417$, n = 134, $p < .01$). In addition, significant correlations were found between the level of concern and ecological orientation ($r = 0.466$, n = 134, $p < .01$) and the level of concern and environmental behavior ($r = 0.377$, n = 134, $p < .01$). Acceptance and support for climate change measures was also observed to correlate positively with ecological orientation ($r = 0.416$, n = 134, $p < .01$), while a less strong relationship was found with environmental behavior ($r = 0.189$, n = 134, $p < .05$).

Regarding “willingness to pay” of respondents for adaptation purposes and climate change, the results of correlation analysis show that general concerns about climate change is the most significant factor with a Pearson correlation coefficient of 0.369, 0.371,
and 0.267 at the 0.01 significance level, respectively, for realizing willingness to pay by higher taxes, cuts in income, or higher prices for goods and services. Demographic factors were not significantly affecting willingness to pay at 0.01 significance level.

**Interviewees’ perceptions of climate change**

**Degree of concern for climate change**

On the whole, interviewees were concerned about climate change. They provided a number of reasons for their attitudes towards climate change topics. Most interviewees commented on the priorities of individuals, criticizing the general hectic lifestyle and the preoccupation with work and school of the average citizen, which leaves no time to recognize shifts in the weather or other natural phenomena. Several interviewees had observed that the environment of Singapore buffers much of the negative impacts, and thus climate change may not be high on the list of concerns for many. Others suggested that misinformation and lower education standards limit the degree of awareness. A few interviewees also asserted that economic benefits may be the source of nonchalance and denial of climate change measures. Further, as brought up by one interviewee, the combination of the geographical location and a lack of natural disasters has contributed the disregard for the environment amongst citizens.

**Support and confidence for climate change adaptation actions**

The majority of interviewees responded that they were not particularly assured that climate change adaptation measures could alleviate the impacts. Most had the opinion that for adaptive measures to be effective, the community needs to act together as a whole and that therein lies the main obstacle. The attitudes and mindsets of the citizens elicited the most comments in all of the interviews, with most responding that there is a general apathy amongst individuals about climate change and the environment as a whole. As summed up by one interviewee: “The problem (is), though, with the attitudes of the people. Most don’t care, and the work of one or just several is not going to create change.” Apart from citizens’ attitudes, the physical geography of Singapore was listed as a reason for non-confidence: the small size of the country together with an absence of natural resources cast some skepticism as to whether the nation has the ability to adapt to climate change. Contradictory viewpoints were presented about the government’s role in moderating the confidence for climate change adaption measures. Some interviewees mentioned a lack of confidence in governmental practices, commenting that a change in policies towards a trend for pro-environmental actions is required. On the other hand, some interviewees expressed a level of confidence in the government. For example, it was observed by one interviewee that there have been some infrastructure improvements that appear to have relieved some of the flooding problems as faced in earlier years. Unpredictability about the future environment and society at large was another factor highlighted by a few interviewees. In particular, it was mentioned that it is not certain if current adaptive measures would be effectual in coping with climate change impacts.
Nearly all of the interviewees indicated anthropogenic reasons as the cause for climate change. Industrial activities, consumption attitudes, specific nations, and government policies were blamed for the phenomenon. One interview responded that climate change may be anthropogenic or part of a natural cycle, stating: "They say it’s humans. Who knows, maybe it is natural. Ice Age was not caused by us, but you can call it a change in climate too."

The majority of interviewees reported global impacts such as increasing global temperatures, rising sea levels, extreme weather, and loss of biodiversity as the key impacts of climate change. At a local level, air pollution, public health, heat-stress, flooding, and dry spells were cited as consequences of climate change on Singapore (see Table 6).

Personal impacts were mainly temperature related, with interviewees specifying warmer temperatures as the main issue as a result of climate change. Most interviewees also commented that the impacts of climate change are not that significant at present, alluding that the effects may get more serious in the future. In adapting to climate change, most of those interviewed stressed the initializing and coordinating role of the government in adapting to climate change. In a paradoxical manner, while efforts led by the authorities are largely perceived to have limited success by the interviewees, most of them have requested more action from the government to lead the adaptation to climate change. One interviewee proposed shared learning with other cities and coordination with other regional governments for a collective adaptive plan to cope with future changes in the environment. Pushing for greater awareness was also proposed as an important step to help the nation to cope with climate change because individual efforts were seen as a key to an overall successful adaptation to environmental issues.

**Table 6. Factors influencing support and confidence for climate change adaptation measures.**

| Factors                      | Qualitative explanation examples                                                                 |
|------------------------------|---------------------------------------------------------------------------------------------------|
| Societal attitudes           | • "… we are too wrapped up with other stuff to think about climate change" (R06)                 |
|                              | • "(adaptation) possible but slowed down by mindset of the people" (R01)                         |
|                              | • "… attitude of the people is a problem" (R02)                                                   |
|                              | • "The thinking of the people is another issue ... people are stressed up and busy ... who would have the time to make an additional effort in caring for the environment ..." (R04) |
| Whole of community effort    | • "if there were ever a choice, between economic growth and being environmentally conscious ... dollars and cents ... prioritized above everything else." (R06) |
|                              | • "Maybe it is because of where Singapore is on Earth, we don’t have natural disasters or seasons so people don’t really care ..." (R05) |
| Unpredictability of future conditions | • "No, we have much more important problems to deal with" (R09)                                      |
|                              | • "And without everyone putting in the effort, there is no point" (R08)                         |
|                              | • "... need a bigger movement - everyone has to chip in" (R02)                                    |
|                              | • "... ultimately individuals have the largest role to play" (R02)                               |
|                              | • "... not sure if we can manage if the effects of climate change are going to be very serious" (R04) |
|                              | • "... might not be feasible to try to adapt ... I don’t know what the scientists have predicted, but how much weather can we predict" (R10) |
| Governmental                 | • "... but the action they take might not be what we want or is ineffective" (R09)               |
|                              | • "I am confident that they will try and do something, but like I said, the effects might be too much to cope" (R10) |
|                              | • "Perhaps we can adapt to a certain extent with ... our strong government ..." (R05)           |
| Geography                    | • "... too small to make substantial changes" (R06)                                              |
|                              | • "... so small and without natural resources, what can we do to adapt" (R09)                   |
Discussion

Perceptions of climate change and risks

The majority of the respondents have indicated that they personally perceive climate change to be of moderate to high risk, and correspondingly ascribed the adaptation to potential climatic risks as important. Amongst the different demographic groups, respondents with higher levels of education considered the importance of adapting to climate change higher than their counterparts. This finding is in line with prior research that has explored the relationship between education and environmental concern and proposes that higher levels of education correspond to significantly greater environmental concern (Marquart-Pyatt 2012; Klineberg et al. 1998). Gender has also been theorized to be an influencing factor on environmental concerns and, in support of this, in the present study, male respondents rated the importance of adapting to climate change higher than females. By analyzing value priorities and linking altruism to environmentalism, Dietz et al. (2002) proposed that there are gender differences in environmental concern but in their study women ranked altruism higher than men and thus the authors concluded that females tend to be more concerned about environmental issues compared to males. Correspondingly, Xiao and McCright (2015) found that women reported greater concern for environmental issues and pro-environmental viewpoints than men.

While respondents on the whole reported a moderate to high level of concern, there appears to be a disconnection between individuals as evidenced from the perceptions of the interviewees. Most of the interviewees within the study reported strong personal beliefs that other citizens do not seem to view the phenomenon with sufficient gravity, citing reasons such as general societal attitudes and hectic lifestyles. Similarly, risk assessment studies conducted in Great Britain have alluded to low levels of concern about climate change, with the general public considering it to be largely related, however, only limited personal importance (Lorenzoni and Pidgeon 2006). Scruggs and Benegal (2012) support the viewpoint that the American public is not particularly worried about climate change and in some cases, there was a marked decline in concern levels, with a spike in skepticism.

Many of the respondents to the online questionnaire perceived themselves as not adequately informed about climate change and there were no significant differences in self-reported climate change knowledge between the sociodemographic groups surveyed. Encouragingly, the majority responded that they would be receptive when given more information on climate change through the internet, television, and newspapers. In the current digital age, the widespread use of this contemporary media channel is especially prevalent in cities (Schaffers et al. 2011; Townsend 2001). For these reasons, future interventions on environmental education should focused on these three media instruments to maximize the scope of reach to the main bulk of the citizens in Singapore. Perceptions from both the questionnaire and interviews converge on the sentiments regarding the future threat of climate change. This view is supported by a number of other studies that found that the general population saw climatic shifts as a temporally and geographically distant threat and relevant to future generations, with less concern and priority for current people (Lorenzoni and Pidgeon 2006).
Out of the six potential climate change impacts, water shortages and depletion of water supplies was regarded as the most critical problem. Water supply in Singapore is partially dependent on the collection of rainfall and these protracted periods of droughts have the potential to cause more severe disruptions to the city. Imported water supply, which currently makes up half of Singapore’s water needs, is affected by dry periods in the same vein. For example, the Republic’s water security was threatened when imported water levels were depleted to historic lows of almost 35% of normal volume during the prolonged dry weather in April 2016 (Siau Ming 2016). Reports have attributed the predicted worsening of these dry seasons to climate change (NCCS 2012). With these recent experiences fresh in the memories of citizens, it is not surprising that the risk of water shortages has ranked highly on the list of concerns. Further highlighting the link between climatic shifts and water, Hansen et al. (2012) states that effects of global climate change is likely to be most heavily felt through its disruptions on the water cycle. At present, the global sea level has been rising at the fastest rate in the past 27 centuries and numerous coastal cities around the world are currently exposed to inundation and erosion by storms and rising sea levels (Wardekker et al. 2010; Satterthwaite et al. 2007). For the low-lying island terrain of Singapore, the prospective level of threat is no different and rising sea levels are in fact likely to pose the most immediate risk from climate change. However, this level of urgency was not reflected amongst the respondents’ concerns and there were several responses indicating that flooding from sea-level rise is not at all a critical threat of climate change. Supporting this view, earlier studies found public knowledge on sea-level rise to be low in Singapore, with a large proportion unconvinced about the use of their payment for adaptation strategies for the protection of natural resources (Ng and Mendelsohn 2006). This could to some extent be explained by the heavily-built environment of the country that offers some measures of physical and psychological security against the risk of flooding. Most of the coastline has been fortified with hard structures such as composite stepped seawalls while at-risk roads near the coast have been gradually raised as preemptive effort to adapt to rising sea levels (NCCS 2012). Extended periods of heavy rains have triggered light flooding in low-lying areas of Singapore in the past (CNA 2016). However, to date, there has yet to be flooding or disruptions due to high sea levels, to convince citizens to account for some of the dissonance between climate change and rising sea levels.

Threats to human health were viewed as the third most critical impact of climate change. As a common domain for individuals of all backgrounds, there have been justifiable calls to bring attention to the link between climate change and health in climate-related dialogs (Nordgren et al. 2016; Leiserowitz 2006). On the other hand, while air pollution has not been predicted as a critical effect of climate change in prior research (Hunt and Watkiss 2011), a number of respondents in the present study have stated air pollution as one of their key concerns of climate change. The heightened level of alarm is likely to be related to the anthropogenic haze that blankets the Southeast Asia region yearly between December and April. Due to uncontrolled agricultural fires spreading into protected forested zones in Sumatra and Borneo, the resulting air pollution spreads over the region and affects Singapore, Malaysia, Indonesia, Philippines, and the south of Thailand. With growing severity in recent years, the 2015/16 haze was particularly deleterious with pollutant indices reaching record heights, leading to school closures and
advisories for the public to remain indoors. Moreover as earlier elucidated, experiential events have been shown to have a significant degree of influence on an individual’s level of concern for a risk (Spence et al. 2011; Weber 2010; Sloman 1996).

**Support and confidence in measures**

Strong support was observed for environmental policies: A wide majority of the respondents indicated agreement with the enactment of environmental protection laws by the government, even if these laws are in conflict with personal and commercial interests. From Stern’s value-belief-norm theory of support for social movements, the willingness to accept material sacrifices for environmental protection is a straightforward indicator of support for environmental policies (Franzen and Vogl 2013; Stern et al. 1999). Moving on to the topic of trust, the relationship between trust in the public institutions and environmental concern has been extensively studied. As defined by Cleary and Stokes (2006), public trust in government can be described as “the extent to which citizens have confidence in public institutions to operate in the best interests of society and its constituents.” Trust in the government has been found to influence an individual’s confidence and support for the authorities’ action in global issues such as climate change (Konisky et al. 2008). The results suggest that to a certain extent, acceptance and support for environmental policies are related to the personal level of concern for climate change as evidenced from the positive relationship between the two. Individuals who indicated a higher level of concern for climate change are on the whole, more likely to accept and support environmental policies. However, there were no significant correlation at 0.01 significance level (Table 5) between “confidence in measures” (including Singapore government preparedness, ability and willingness to cope with climate change) and respondents’ general concern about climate change. Though, all other factors of VBN and NEP theories were significantly correlated with the general concerns about climate change.

**Ecological orientation and environmental behavior**

No clear connection was found between ecological orientation and self-reported environmental behavior: Higher scores on the ecological orientation scale do not necessarily translate to more environmentally conscious behavior. Such a disparity has been previously observed in previous research (e.g. Blake 1999; Burgess et al. 1998). While a number of theoretical frameworks have been developed to explain this pattern, it has been acknowledged that the determinant which shapes behavior is a complex amalgam of sociodemographic aspects, external circumstances, and internal psychological factors (Kollmuss and Agyeman 2002). In another study, Hall et al. (2018) reported that highly concerned respondents (600 adults in total in the US) were most supportive of government climate policies, but least likely to report individual-level actions, whereas the skeptical respondents opposed policy solutions but were most likely to report engaging in individual-level pro-environmental behaviors. Moreover, no differences were observed in our study between the demographic groups regarding their ecological orientation as well as their self-reported environmental behavior, which contrasts prior
studies that found divergences between the groups. According to Dunlap et al. (2000), there is growing evidence that ecological orientation and a pro-environmental worldview corresponds to higher levels of education, younger ages, and liberalism. However, other studies have indicated that younger individuals have more pro-environmental worldviews than older individuals (Gelissen 2007). One possible reason for this lack of distinction between the demographic groups in this study, may be the similarities in experiential factors and social norms. Moreover, the results of our study are valid for the questions’ structure and context. Reporting on one’s own behavior can be profoundly influenced by question wording, format, and context as stated by Schwarz and Oyserman (2001).

Conclusions

In this study, the perceptions of urban city-dwellers towards climate change were examined. The findings suggest that: (1) public concern for climate change is moderate to high in Singapore, and that concern is likely to increase due to the unpredictability of future conditions, (2) more concerned individuals may expend greater support to environmental measures, (3) the wide majority is amenable for governmental pro-environmental laws, but more individuals agree to cuts on living standards as opposed to higher prices and taxes, (4) there are differences in climate change concerns based on education level and gender. Furthermore, between men and women, there are differences in confidence about adaptation measures. It was also observed that ecological orientation (Theory of new ecological paradigm) alone does not equate to pro-environmental behavior, drawing attention to the gap between cognition and behavior. Most of the respondents indicated a paucity of information regarding climate change, and that they are receptive to awareness-raising measures with particular reference to the internet, television, and newspapers as the most effective media instruments. To specify constraints on generality of the findings of this study (as suggested by Simons et al. 2017), we may ask for your attention regarding the setup of the sampling design and its limitations in this study (section “Methods”). The results are spatially limited to Singapore and temporally to the present time (2017) and emphasize the future crucial needs for adaptation measures much more than the current efforts of the government in Singapore. The findings show that the inhabitants of Singapore, being concerned about climate change and impacts, are ready to contribute to the cost of improved adaptation measures in the future.

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Appendix A

Questions Used for Data Collection

Table A1. Questions used in the online questionnaire.

| Questions                                                                 | Possible Responses                                                                 |
|--------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| In general, how concerned are you about climate change?                   | 1 (Not concerned at all) to 5 (extremely concerned)                                 |
| How much do you think climate change has affected and will affect you personally? | 1 (Not at all) to 5 (Extremely Affected)                                             |
| In the past and currently                                                |                                                                                     |
| In the future                                                            |                                                                                     |
| How much do you think climate change has affected and will affect Singapore? |                                                                                     |
| In the past and currently                                                |                                                                                     |
| In the future                                                            |                                                                                     |
| From a scale of 1 to 5, how critical are the following impacts?           |                                                                                     |
| Flooding and erosion of low-lying areas due to rising sea levels.         |                                                                                     |
| Loss of natural habitats as well as decline in the variety of plants and animals. |                                                                                     |
| Negative impacts on human health through heat stress, spread of infectious diseases, and haze. |                                                                                     |
| More frequent and severe weather such as heavy rainfall and dry spells.  |                                                                                     |
| Shortage and depletion of water supply.                                  |                                                                                     |
| Disruptions to food supply and price spikes.                            |                                                                                     |
| How important do you think it is for Singapore to adapt to climate change? | 1 (Not important at all) to 5 (Extremely important)                                 |
| Do you know of any projects designed to help Singapore cope with climate change? | Yes/No                                                                             |
| Have you heard of the National Climate Change Strategy or the Climate Action Plan? |                                                      |
| Would you like to be given more information on how Singapore is adapting to climate change? |                                                      |
| In your own opinion, how much do you know about the causes of climate change? | (1) Know nothing at all to (5)                                                      |
| Know a great deal                                                        |                                                                                     |
| In your own opinion, how much do you know about the solutions to cope with climate change? |                                                      |
| Who do you think is mainly responsible for taking action on climate change in Singapore? |                                                      |

*To what extent do you agree or disagree with the following statements?*

| I would be willing to pay much higher taxes in order to protect the environment. | (1) Strongly disagree to (5) | Strongly agree |
| I would be willing to accept cuts in my standard of living to protect the environment. | (1) Strongly disagree to (5) | Strongly agree |
| The government should pass laws to make ordinary people protect the environment, even if it interferes with people's rights to make their own decisions | Yes/No |
| The government should pass laws to make businesses protect the environment, even if it interferes with businesses' rights to make their own decisions. | (1) Strongly disagree to (5) | Strongly agree |

*To what extent do you agree or disagree with the following statements?*

| Singapore has the ability to adapt to climate change. | (1) Strongly disagree to (5) | Strongly agree |
| Singapore is well-prepared to cope with climate change. | (1) Strongly disagree to (5) | Strongly agree |
| The government will take care of the climate change issue. | (1) Strongly disagree to (5) | Strongly agree |

*To what extent do you agree or disagree with the following statements?*

| The earth is like a spaceship with very limited room and resources. | (1) Strongly disagree to (5) | Strongly agree |
| Humans are negatively impacting the environment. | (1) Strongly disagree to (5) | Strongly agree |
| The balance of nature is strong enough to cope with the impacts of modern industrial nations. | (1) Strongly disagree to (5) | Strongly agree |

*Denotes key questions used for further statistical analyses.*
Table A2. Guiding questions used in the semi structured interviews.

Questions:
What do you think of when you hear the term climate change?
Do you see climate change as an important issue/problem?
Have you been affected by climate change personally?
Who do you think is responsible/to blame for climate change?
Do you think it is possible/important for Singapore to adapt to climate change?
When do you think Singapore will begin to feel the effects of climate change?
What do you think is the most critical/important impact on Singapore?
Who do you think is in charge of helping Singapore adapt to climate change?
Who do you think should be in charge of helping Singapore adapt to climate change?
Are you confident that they can help Singapore adapt sufficiently?
If you get the opportunity to be in charge, what do you think you would do?
Do you know of any measures taken to help Singapore adapt to future impacts of climate change?
In general, do you think Singaporeans care about climate change? Why?
Do you think individuals can make a difference?
As an individual, what do you think one can do to make a difference?

Appendix B

Demographic distribution of respondents

Table B1. Demographic distribution of questionnaire respondents.

| Sex    | Females   | Males    |
|--------|-----------|----------|
|        | 59.7%     | 40.3%    |

| Ethnic Distribution | Chinese | Malay | Indian | Others |
|---------------------|---------|-------|--------|--------|
|                     | 83.6%   | 9.7%  | 3%     | 3.7%   |

| Age          | 0–18 | 19–24 | 25–34 | 35–44 | 45–54 | 55–64 |
|--------------|------|-------|-------|-------|-------|-------|
|              | 6%   | 10%   | 56%   | 16%   | 8%    | 4%    |

| Education Level | Below Secondary | Secondary | Post-secondary | Bachelor’s Degree | Post-graduate |
|-----------------|-----------------|-----------|----------------|-------------------|---------------|
|                 | 0%              | 5%        | 25%            | 60%               | 10%           |

Table B2. Demographic distribution of participants in the semi-structured interviews.

| Serial Code | Eco orientedness | Gender | Age group | Education            | Area of employment |
|-------------|------------------|--------|-----------|----------------------|--------------------|
| P01         | Yes              | F      | 25–34     | Post-graduate Degree | Student            |
| P02         | Yes              | F      | 25–34     | Bachelor’s Degree    | Public             |
| P03         | No               | F      | 25–34     | Bachelor’s Degree    | Private            |
| P04         | Yes              | F      | 35–44     | Bachelor’s Degree    | Public             |
| P05         | Yes              | F      | 45–54     | Post-secondary       | Homemaker          |
| P06         | No               | F      | 35–44     | Bachelor’s Degree    | Private            |
| P07         | Yes              | F      | 0–18      | Post-secondary       | Student            |
| P08         | Yes              | F      | >65       | Primary              | Private            |
| P09         | No               | M      | 55–64     | Secondary            | Private            |
| P10         | No               | M      | 25–34     | Bachelor’s Degree    | Private            |

*Eco Orientedness was a self-reported characteristic asked before the commencement of the interview.
Appendix C

Climate change perceptions

Figure C1. Potential climate change impacts in Singapore and how critical each impact was perceived to be.

Appendix D

Ecological orientation and environmental behavior

Table D1. Frequency distribution of new ecological paradigm scale items\textsuperscript{a,b} (n = 134).

| Item                                                                 | Mean\textsuperscript{c} | S.D.\textsuperscript{d} |
|----------------------------------------------------------------------|--------------------------|--------------------------|
| 1. The earth is like a spaceship with very limited room and resources| 3.92                     | 0.86                     |
| 2. The so-called “ecological-crisis” facing humankind has been greatly exaggerated | 3.66                     | 1.01                     |
| 3. Humans are negatively impacting the environment                  | 3.99                     | 0.93                     |
| 4. The balance of nature is strong enough to cope with the impacts of modern industrial nations 5. If things continue on their present course, we will soon experience major ecological issues | 4.14                     | 0.89                     |
| 6. Humans have the right to modify the natural environment to suit their needs | 3.39                     | 1.11                     |
| 7. Despite our special abilities humans are still subjects to the laws of nature | 3.94                     | 0.86                     |

\textsuperscript{a}Question wording: “To what extent, do you agree or disagree with the following statements?”.

\textsuperscript{b}Agreement with the odd numbered items and disagreement with the even numbered items indicate pro ecological worldviews.

\textsuperscript{c}Responses for even numbered items, where disagreement reflect pro ecological worldviews, are reversed for the calculation of mean.

\textsuperscript{d}Standard Deviation.

Table D2. Percentage distribution of self-reported ecologically responsible behavior\textsuperscript{a} (n = 134).

| Item                                                                 | 1\textsuperscript{b} | 2 | 3 | 4 | 5 | Mean | S.D.\textsuperscript{c} |
|----------------------------------------------------------------------|-----------------------|---|---|---|---|------|--------------------------|
| 1. Choose appliances with energy and water efficient labels         | 2%                    | 4%| 40%| 31%| 22%| 3.68 | 0.94                     |
| 2. Turn off electrical mains when not in use                        | 1%                    | 8%| 19%| 35%| 37%| 4.00 | 0.98                     |
| 3. Use public transport whenever possible                           | 0%                    | 11%| 20%| 36%| 33%| 3.90 | 0.98                     |
| 4. Avoid food wastage                                               | 0%                    | 2%| 20%| 46%| 32%| 4.07 | 0.78                     |
| 5. Reduce, reuse, recycle to minimize waste                         | 0%                    | 3%| 46%| 34%| 18%| 3.66 | 0.80                     |

\textsuperscript{a}Question wording: “How often do you practice the following actions?”.

\textsuperscript{b}1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always.

\textsuperscript{c}Standard Deviation.