How Education on Climate Change Affects Consumers' Willingness to Participate in Carbon Offsetting Programs?

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If airlines could have a better understanding of how to induce sustainable behavior in their customers, they can use these methods when building sustainable initiatives such as voluntary carbon offsetting programs. The purpose of the study was to determine if education on the consequences of climate change affects how consumers behave related to their interaction with carbon offsetting programs. Regional Scenarios were introduced with a natural disaster comparable to the region under review. A multistage sampling technique was utilized in this study. Firstly, using a cluster sample, groups were used rather than individual units of the target population. The results indicate that education significantly influences behavior compared to behavior before education. Based on the results of this study, we recommend that airlines modify their sustainability initiatives by educating the consumer on the purpose behind the initiative before asking for participation.

Introduction

Today, aviation accounts for nearly 3.5% of global carbon dioxide (CO_2) emissions (DLGR, 2021). Companies and regulators within the aviation industry have been working to become more sustainable through nationwide political measures, including the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) and the European emissions trading system (ETS) (Wild et al., 2021). Flight taxes and compensation programs are a few political measures created for airlines (Wild et al., 2021). For example, as of June 2021, Switzerland has created a flight tax per traveling passenger from 30 to 120 Swiss Frances (Wild et al., 2021). "Flight tax" is the ticket tax charged at the destination point and is supposed to offer flexibility in the aviation industry (Wild et al., 2021). Although the current study is based in the United States (U.S.), by introducing one of the biggest global carbon markets (ETS), the cap-and-trade system is vital for understanding flight tax (Wild et al., 2021).

The European Economic Area is currently the only market under the control of the EU ETS; however, starting at the end of 2023, the system will apply to all carriers entering the country, including the U.S. (Wild et al., 2021). This system has a fixed cap, which decreases annually. A polluter such as an airline has specific allowances they can emit, for example, two tons of CO_2 (Wild et al., 2021). The allowances can be traded with other airlines to compensate for their emissions. If the company runs out of allowances, a fee is imposed on them, with the goal being for these companies to start investing in clean, renewable energy (Wild et al., 2021).

Carbon offsetting is another market-based approach to reducing CO_2, which refers to lowering emissions of CO_2 to compensate for emissions generated in other parts of the operation (Wild et al., 2021). ICAO adopted CORSIA in 2016 to create this offsetting carbon system. Compared to the EU ETS, CORSIA is the only international aviation climate protection instrument (ICC, 2019). The aviation industry is currently in the pilot phase of CORSIA (2021 - 2023). We will transition into the first phase in 2024, where member states can voluntarily participate in CORSIA (Wild et al., 2021).

Purpose

The study examines whether education on climate change influences consumers' willingness to participate in airlines' carbon offsetting programs.

Importance of the Study

According to Masud et al. (2016), education and awareness determine positive, sustainable behavior; therefore, this study hopes to find a stronger percentage of participants willing to become involved with carbon offsetting programs after education. The airlines within the U.S. would value the information received in this study because they can begin these

sustainability programs by evaluating their consumer's knowledge level on climate change and proceed from there to have the most beneficial impact.

Research Question

How does education on climate change influence an individual's willingness to participate in voluntary carbon offsetting programs?

Familiarity with Climate Change

The Intergovernmental Panel on Climate Change (IPCC) has stated that the changing climate problem is one of the more pressing challenges this century (IPCC, 2013). The harm caused by global warming is likely to be unalterable if no action is taken now and into the future to steady the temperature of the Earth's surface. The IPCC report and many other universal environmental organizations believe climate change is artificial. Understanding people's perceptions of climate change is a starting point for this study. However, research has argued that knowledge about climate change is not an essential predictor of concern (Kellstedt et al. 2008).

In contrast, others have determined that knowledge is fundamental (Kellstedt et al., 2008) (Eden, 1998). A 2015 study from the Institute for Environmental Decisions in Zurich, Switzerland, examined how important comprehension of climate change is for people's concern about climate change. The finding was comparable with previous studies showing that scientific knowledge may influence public concern and attitude about climate change (Shi et al., 2015). Shi et al. (2015) research also suggested that people who believe they cannot do anything about a hazard will not change their behavior even when they have more knowledge. Airline consumers knowledgeable about climate change might not be willing to give up their frequent flyer miles until they understand that their contribution would significantly help airlines fund carbon offsetting programs. To change people's behaviors regarding climate change, Shi et al.'s (2015) research suggests that people should be provided with casual knowledge (i.e., information on CO_2, temperature warming trends, and climate changes).

Voluntary Carbon Offsetting Programs

Voluntary carbon offsetting programs (VCOP) give eco-minded people the opportunity to compensate for their carbon emissions emitted while flying (Kerner and Brudermann, 2021). Due to increased awareness of climate change, the expectation is to see a higher VCOP. The main idea behind VCOP is to compensate for as many carbon emissions caused by the initial action. This carbon-neutral idea would allow passengers to support airline programs that ensure they take the initiative to offset the emitted carbon of that person's flight. As of today, purchases of VCO have remained low. Studies estimate that less than 10% of passengers have offset at least one flight, and the percent of flights that have been carbon neutral is in the single-digit range (Mair, 2011). This could be from a lack of education about VCOP or an opportunity to participate in the airline industry. Lu and Wang (2018) assume that the sparse carbon offsetting purchases is related to a lack of understanding of the programs and awareness of climate change implications. Current VCOP has no obligation for a consumer, but theoretically, most people should be interested in offsetting their emissions, as climate change will affect all humans in one

way (Lu and Wang, 2018). VCOP has been a way to reduce "flight shaming," which is the unease with using air travel for fear of climate implications and public opinion. Purchasers of VCOP have used these programs to travel to distant locations by airplane while minimizing personal carbon emissions.

Mair (2011) created a study to determine what type of people are purchasing VCOP and if those purchasing these programs also show signs of pro-environmental behavior in other ways. The study suggests that individuals who are already willing to contribute to sustainable initiatives are the best audience to target. In a 2007 study, Metz et al. (2007) stated that VCOP needs to be relatively low cost and easy to access to positively attract individuals. A VCOP suggested in this study enables passengers to donate back their frequent flyer miles and loyalty program points to the airline to sustain VCOP. Today, some airlines offer the option to purchase carbon offset credits in ticket transactions (e.g., Qantas and British Airways) (Mair, 2011). Examples of carbon offset programs discussed in Mair's study were avoiding deforestation, afforestation and reforestation, fugitive gases, fossil fuel substitution, and energy efficiency (Mair, 2011). Mair's (2011) exploring air travelers' VCO behavior tested if respondents had offset a flight by purchasing a COP. The results indicated that only 10% of the respondents had purchased, 80% had not purchased VCO before, and 10% were unsure (Mair, 2011). Unfortunately, this and similar studies demonstrate that passengers do not show much willingness to adopt voluntary mitigation initiatives. In contrast, some studies show passengers may only be WTP or act if other passengers do (Winter et al., 2021) (McKercher et al., 2010) (Brouwer et al., 2008). This further exemplifies understanding if education would make a difference in passengers' WTP and act in sustainable initiatives.

Scenario Background

Masud et al. (2016), Pearson and Hamilton (2014), and Rasoli et al. (2019) indicated that introducing a scenario and retesting the theory of planned behavior (TPB) is a way to compare behavioral intention with the same participant. Educational material was collected from the Third National Climate Assessment, which breaks down climate influences in the U.S.   region (Horton et al., 2014). This assessment categorized each region of the U.S. to determine three to five notable natural devastating events caused by climate change currently impacting that region. The assessment expands on what will happen to this region if no action exists to extenuate climate change. The following are excerpts from the scenarios and continued literature from the assessment

The introduction of the scenario section included the basic science of climate change, stating that the known cause has been arising in burning fossil fuels since the industrial revolution (UNFCCC, 2015). Discuss further the concern that if the global temperature increases above 2C, natural disasters are expected to become stronger and more frequent (UNFCCC, 2015). Despite the airline's efforts to pursue sustainable initiatives, aviation accounts for around 3.5% of global CO2 emissions (DLR, 2021). VCOP could help mitigate this amount of CO2 by taking CO2 from the atmosphere and investing in sustainable aviation fuels and projects (Kerner and Brudermann, 2021).

The northeastern region of the U.S. not only holds some of the world's more developed cities but is home to major financial centers, the nation's capital, and multiple defining historical landmarks (Horton et al., 2014). One natural disaster that impacted the N.E. was Hurricane Irene, causing massive coastal damage, storm surge, and flooding along the N.E. coastline (Horton et al., 2014). During its impact, Irene produced two to three inches of rainfall per hour in certain areas in late August 2011. A natural disaster, Hurricane Sandy, followed in October 2012, becoming the second most expensive Atlantic hurricane in history (Horton et al., 2014). The northeastern hurricanes, extreme winters, record-breaking heat waves, and flooding cities are due to changes in the Earth's temperature from trapped CO_2 in our atmosphere (Horton et al., 2014).

The midwestern region is home to more than 61 million people with expansive agricultural lands, forests, lakes, and populous cities (Pryor et al., 2014). in the upcoming years, the concern with living in the M.W. has stronger heat wave intensity and frequency, leading to the intense humidity, worsened air quality, and lower water quality affecting public health (Pryor et al., 2014). Prior studies indicate that there will be an increase of up to 2,217 excess deaths per year due to heat stress in Chicago alone by 2081 (Pryor et al., 2014). The M.W. is also characterized by a rich and diverse forest full of natural ecosystems, wetlands, and native species (Pryor et al., 2014). M.W. forests are an amazing absorber of CO_2 and absorb more CO_2 than they emit (Pryor et al., 2014). With weather patterns causing record-breaking high temperatures, insect outbreaks, and increased humidity, this area might soon be changed from a carbon absorber to a carbon-emitting region (Pryor et al., 2014).

The southern region of the U.S. draws in millions of visitors each year (Carter et al., 2014). One primary concern is reduced water availability due to increased evaporation from increasing temperatures in the upcoming years. With the projected increase in population in the S.E., the continued expansion of the urbanized area will expand these residents' water needs and potentially threaten freshwater qualifiers by exacerbating saltwater during urbanization. Higher sea levels speed saltwater intrusion into freshwater supplies like rivers, streams, and wells. City officials in Hallandale Beach, Florida, have already announced the abandonment of six of their eight drinking water wells (Berry et al., 2011). Food security and increased demand for water are directly related to changes within our southeastern ecosystem. Temperature increase caused by carbon emissions has already shown signs of a War on food and water in the S.E. (Berry et al., 2011).

The southwestern region of the U.S. is the hottest and driest region, while the northwestern region has a complex climate, including snow, fires, and volcanic activity. Increased wildfire risk will alter N.W. forests and increase tree disease outbreaks caused by climate change (Mote et al., 2014). Relative to the 1916 to 2007 period, by the 2080s, the median annual area burned is expected to quadruple to two million acres (Mote et al., 2014). To compensate for the high temperatures, extensive air conditioning can quickly increase the electricity demand and lead to energy system failure or blackouts where the city shuts down the power grid (Mote et al., 2014). Heat stress is already a reoccurring problem for urban residents (Mote et al., 2014). As temperatures are expected to increase, if nothing is done to improve the electricity grid, rolling blackouts could be expected to occur much longer (Mote et al., 2014). Wildfires brought on by these excessive high-temperature days create human respiratory issues,

reduce air quality from chemical reactions occurring faster, and cause more disease (Garfin et al., 2014).

Methodology

Using the model from Masud et al. (2016), Pearson and Hamilton (2014), and Rasoli et al. (2019), scenarios explaining climate change disasters in different regions of the country were introduced. The purpose was to determine if participants behaved positively after education on climate change. The fully hypothesized structural model of the factors of carbon offsetting programs before and after education is presented in Figure 1. The arrows indicate a proposed relationship between constructs.

Figure 1
The Structural Model
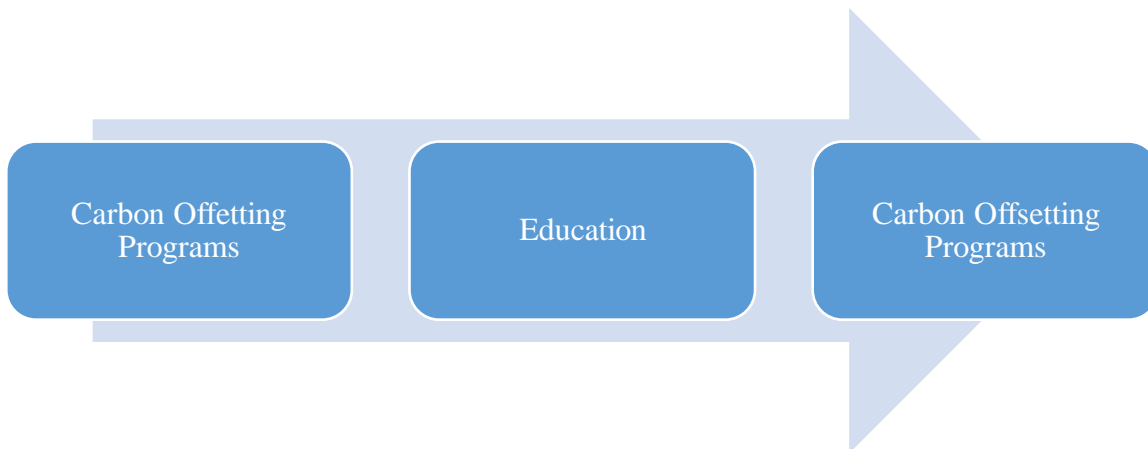
The use of scenarios in this study is factual rather than a fiction story, like in Rasoli's (2019) study. All regional scenarios introduced a natural disaster comparable to each region. Refer to Appendix A for the study survey. The scenario inclusion was adapted from Masud et al. (2016), Pearson and Hamilton (2014), and Rasoli et al. (2019). The participants completed the nine demographic questions, followed by two questions, one education scenario, and then repeated the survey. Information from each scenario came from (Horton et al.), (Pryor et al., 2014), (Carter et al., 2014), (Lincoln et al., 2021), (Mote et al., 2014), and (Garfin et al., 2014). Each scenario went through a natural disaster caused by climate change in that region. Each region's information was summarized and given to the participants. Participants were only required to read the regional scenario in which they reside. However, they were encouraged to learn about the different natural disasters impacting the U.S. Scenarios were broken down into the northeast (N.E.) region, Southeast (S.E.) region, Midwest (M.W.) Region, and West region. The NE region consisted of M.D., DE, NJ, CT, RI, MA, VT, PA, NY, NH, and M.E. The S.E. region consisted of A, WV, KY, TN, GA, NC, SC, FL, AL, MS, LA, AR, OK, and TX. The M.W. region consisted of N.D., SD, NE, KS, MN, IA, MO, WI, IL, IN, MI, and O.H. The West region consisted of A.K., HI, WA, OR, MT, ID, WY, CO, UT, NV, CA, AZ, and N.M. Each scenario explained that region's natural disaster and the devastation it has caused as well as solutions. The Frequent Flyer Program questions in the demographics section were the control variable. Data was collected to see if participants were active in airline or other loyalty

programs. It was not required to already participate in a frequent flyer or loyalty program. The VCOP construct combined two survey questions from Mairs's (2011) research exploring air travelers' VCO behavior and Terblanche's (2015) study understanding the perceived benefits of loyalty programs.

The current study compared the means of carbon offsetting behavior from before and after education using a paired t-test. Descriptive statistics were used to report on the returned demographic information.

Participants

Participants were recruited via a link sent out through Instagram and Facebook, by the Women in Aviation Association via email, and through Embry Riddle Aeronautical University organizations through word of mouth. The survey was conducted in the United States in March 2022. The survey was made available to all U.S. residents to achieve the most comprehensive results for airlines around the country to use. Two hundred thirty-seven responded to the questionnaire, and 97 completed both surveys.

Results

Respondent Demographics

The sample consisted of 57.73% males (n =56), 42.26 % females (n = 41), .87% nonbinary (n = 1), and .87% (n = 1), people who did not report their gender. Concerning marital status, 29.6% of the respondents were married, and 60.9% of the participants were single. The reported education level was less than high school (0%, N= 0), high school graduate (3.6%, N= 4), some college (no degree) (10.4%, N= 12), nonformal education (1%, N=.87), associate degree (9.6%, N= 11), bachelor's degree (52.2%, N= 60), master's degree (15.7%, N= 18), doctorate (7%, N= 8). The education level in our sample was higher than that of the general population (Educational Attainment, 2017).

Participants ranged from Boomers to Generation Z. Most of the responses corresponded are Millennials (45.21%), followed by Generation Z with 26%. Participants' primary travel purpose was for leisure/vacation. Participants primarily traveled individually. Participants mean traveling time is twice a year. Participants ranged from the usage of frequent flyer programs to other loyalty programs. 45.2% of participants use frequent airline flyer programs.

Participants were residents from all regions of the U.S. The distribution of respondents by region is reflected in Table 1.

Table 1
Respondents by Region

Region	Frequency	Percent of Total	Cumulative Percent of Total
Midwest	9	8.2568807	8.2568807
Northeast	28	25.688073	33.944954
South	35	32.110092	66.055046
West	36	33.027523	99.082569

Hypothesis 1

This research seeks to test the following hypothesis：

H1a: There is a difference in behavior to volunteer for carbon offset programs between individuals educated about climate change and those not educated.

H10: There is no difference in behavior to volunteer for carbon offset programs between individuals educated about climate change and those not educated.

A paired t-test (Table 2) was used to show whether behavior's sample means after education is different than the sample means of behavior before education. A t-test for dependent means was used because the research constructs were repeated. The comparison distribution is a t-distribution with N-1 degrees of freedom = 96 *df.* This is a paired test with 96 degrees of freedom, and we tested at the .05 significance level. We received a p-value of 0.002. We reject the null hypothesis. There is a significant difference in behavior to volunteer for carbon offset programs between individuals educated about climate change and those not educated. Hypothesis 1 is supported.

Table 2
Paired T-Test Results

μD = μ1 - μ2: Mean of the difference between COP 1 and COP 2
H0 : μD = 0
HA: μD ≠ 0

Sample Statistics

Sample	n	Mean	Std. Dev.
COP 1	97	2.9347079	1.2106197
COP 2	97	2.7800687	1.3027185

Hypothesis Test Results:

Difference	Mean	Std. Err.	DF	T-Stat	P-value
COP 1 - COP 2	0.15463918	0.048621179	96	3.18049	0.002

Limitations

This analysis is not without any limitations. This study represents data from U.S residents over 18. This consideration may limit the generalizability of the findings beyond this specific sample. The analysis was also based on preference data that may present hidden biases that highlight instinctual ways individuals make selections. Even though this work examines whether education on climate change influences consumers' willingness to participate in airlines' carbon offsetting programs, we cannot confirm that this translates into actual behavior change.

Conclusion

A comprehensive literature review was completed, factors contributing to climate change initiatives were identified, and one hypothesis was tested. A survey instrument was used to collect data from a sample of travelers within the U.S. Our hypothesis was supported through a t-test and contained specific behaviors like, "I would purchase a carbon offset for a flight." Participants understood the behavior and acted based on their newfound education and knowledge rather than their emotions, ethics, or morals.

Recommendations for Practice

Airlines are constantly working towards the 2050 goal of carbon-neutral within the aviation industry. One key component to carbon neutrality is using good, reliable carbon offsetting programs. Knowing that airlines can receive assistance from their consumers through education in funding these projects and many others is valuable to the industry. Understanding what affects their behavior is an important and challenging component of getting stakeholder and

consumer engagement. This study can help airlines understand the importance of education and its impact on behavior change of their consumers and stakeholders.

Recommendations for Future Research

Multiple paths for future research have surfaced since the beginning of our study and results from the data. First, we collected a convenience sample of data from only U.S. residents. We suggest a targeted sample be used to find individuals who travel most often or use reward programs frequently. To advise airlines, it would be best to gather data from people who support the suggested behavior the best, giving back points/miles to support initiatives.

Second, , a different source of education that is still related to climate change could be used to test the model. This study focused on natural disasters in the resident's area, whereas other research could educate the applicant about changes to agriculture or transportation from ongoing climate change.

References

Anderson, G. B., and M. L. Bell, 2011: Heatwaves Heatwaves in the United States: Mortality risk during heat waves and effect modification 56. by heat wave characteristics in 43 U.S. communities. *Environmental Health Perspectives*, 119, 210-218, doi:10.1289/ehp.1002313.

Berry, L., F. Bloetscher, N. Hernández Hammer, M. Koch-Rose, D. Mitsova-Boneva, J. Restrepo, T. Root, and R. Teegavarapu, 2011: Florida Water Management and Adaptation in the Face of Climate Change, 68 pp., Florida Climate Change Task Force. Available online at http://floridaclimate.org/docs/water_managment.pdf

Brouwer, R., Brander, L., & Van Beukering, P. (2008). "A convenient truth": Air travel passengers' willingness to pay to offset their CO2 emissions. *Climatic Change, 90*, 299–313.

Busch, T., & Judick, L. (2021). Climate change—that is not real! A comparative analysis of Climate-skeptics-sceptic think tanks in the USA and Germany. *Climatic Change, 164*(1-2) https://doi.org/10.1007/s10584-021-02962-z

Carter, L. M., J. W. Jones, L. Berry, V. Burkett, J. F. Murley, J. Obeysekera, P. J. Schramm, and D. Wear, 2014: Ch. 17: Southeast and the Caribbean. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 396-417. doi:10.7930/J0N- P22CB.

DGLR, 2021. Sustainability in Aviation. In: Roˈtger, T. (Ed.), *Aviation & Aerospace*, DGLR edition 1. DGLR, Bonn(in German), 29–33.

Eden S. Environmental issues: Knowledge, uncertainty and the environment. Progress in Human Geography, 1998; 22(3): 425–432.

Educational Attainment, by Race and Ethnicity - Race and Ethnicity in Higher Education. Race and Ethnicity in Higher Education. (2017). https://www.equityinhighered.org/indicators/u-s-population-trends-and-educational-attainment/educational-attainment-by-race-and-ethnicity/

Garfin, G., G. Franco, H. Blanco, A. Comrie, P. Gonzalez, T. Piechota, R. Smyth, and R. Waskom, 2014: Ch. 20: Southwest. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 462-486. doi:10.7930/J08G8HMN.

Horton, R., G. Yohe, W. Easterling, R. Kates, M. Ruth, E. Sussman, A. Whelchel, D. Wolfe, and F. Lipschultz, 2014: Ch. 16: Northeast. *Climate Change Impacts in the United States: The Third National Climate Assessment,* J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 16-1-nn.

IATA. Airlines expect a 31% rise in passenger demand by 2017. Available online: http://www.iata.org/pressroom/pr/pages/2013-12-10-01.aspx

ICC, 2019. ICC signs a partnership at COP25 to support a carbon-neutral aviation industry. Available online: https://iccwbo.org/media-wall/news-speeches/icc-signs-partners hip-at-cop25-to-support-a-carbon-neutral-aviation-industry

International Chamber of Commerce, ICC, Headquarters, Paris, Fr.

IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK, and New York, NY: Cambridge University Press 2013.

Kellstedt PM, Zahran S, Vedlitz A. Personal efficacy, the information environment, and attitudes toward global warming and climate change in the United States. Risk Analysis, 2008; 28(1):113–126.

Kerner, C.; Brudermann. I Believe I Can Fly—Conceptual Foundations for Behavioral Rebound Effects Related to Voluntary Carbon Offsetting of Air Travel. *Sustainability* 2021,*13*,4774. https://doi.org/ 10.3390/su13094774

Lincoln Lenderking, H., Robinson, S., & Carlson, G. (2021). Climate change and food security in caribbeanCaribbean small island developing states Challenges and strategies. *International Journal of Sustainable Development and World Ecology, 28*(3), 238-245. https://doi.org/10.1080/13504509.2020.1804477

Lu, J., & Wang, C. (2018). Investigating the impacts of air travelers' environmental knowledge on attitudes toward carbon offsetting and willingness to mitigate the environmental impacts of aviation. *Transportation Research. Part D, Transport and Environment, 59*, 96-107. https://doi.org/10.1016/j.trd.2017.12.024

Mair, J. (2011) Exploring air travelers' voluntary carbon-offsetting behavior, Journal of Sustainable Tourism, 19:2, 215-230

Masud, M. M., Al-Amin, A. Q., Junsheng, H., Ahmed, F., Yahaya, S. R., Akhtar, R., & Banna, H. (2016). Climate change issue and theory of planned behavior: Relationship by empirical evidence. *Journal of Cleaner Production, 113*, 613-623.

McKercher, B., Prideaux, B., Cheung, C., & Law, R. (2010). Achieving voluntary reductions in the carbon footprint of tourism and climate change. *Journal of Sustainable Tourism, 18*(3), 297–317.

Metz, B., Davidson, O.R., Bosch, P.R., Dave, R., & Meyer, R.A. (Eds.). (2007). Climate change 2007: *Mitigation. Contribution of working group III to the fourth assessment report of the IPCC. Cambridge: Cambridge University Press; IPCC.*

Mote, P., A. K. Snover, S. Capalbo, S. D. Eigenbrode, P. Glick, J. Littell, R. Raymondi, and S. Reeder, 2014: Ch. 21: North- west. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Rich- mond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 487-513. doi:10.7930/J04Q7RWX.

Nunez, S., Arets, E., Alkemade, R., Verwer, C., & Leemans, R. (2019). Assessing the impacts of climate change on biodiversity: Is below 2 °C enough? *Climatic Change, 154*(3-4), 351-365. https://doi.org/10.1007/s10584-019-02420-x

Pearson, M., & Hamilton, K. (2014). Investigating driver willingness to drive through flooded waterways. *Accident Analysis and Prevention, 72*, 382-390. https://doi.org/10.1016/j.aap.2014.07.018

Pryor, S. C., D. Scavia, C. Downer, M. Gaden, L. Iverson, R. Nordstrom, J. Patz, and G. P. Robertson, 2014: Ch. 18: Midwest. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Rich- mond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 418-440. doi:10.7930/J0J1012N.

Rasoli, M., Mirrezaie, S. M., Fooladi, E., Hosseini, R. Z., & Fayaz, M. (2019). Effects of reviewing childbirth scenarios on the choice of delivery type: A randomized controlled trial. *Turkish Journal of Obstetrics and Gynecology, 16*(1), 15-22.

Shi, J., Visschers, V. H. M., & Siegrist, M. (2015). Public perception of climate change: The importance of knowledge and cultural worldviews. *Risk Analysis, 35*(12), 2183-2201. https://doi.org/10.1111/risa.12406

UNFCCC (2015) Adoption of the Paris Agreement. Report No. FCCC/CP/2015/L.9/Rev.1. UNFCCC, Bonn, http://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf

Wild, P., Mathys, F., & Wang, J. (2021). Impact of political and market-based measures on aviation emissions and passenger behaviors (a swiss case study). *Transportation Research Interdisciplinary Perspectives, 10*, 100405.

Winter, S., Crouse, S., & Rice, S. (2021). *The development of 'green' airports: Which factors influence willingness to pay for sustainability and intention to act? A structural and mediation model analysis*. Science Direct.

Appendix A   Questionnaire

Descriptive and demographic statistics of study participants

Gender
-   Male
-   Female
-   Nonbinary
-   Transmasculine
-   Other

Ethnicity
-   Caucasian
-   African Descent
-   Hispanic Descent
-   Asian Descent
-   Other
-   No Response

Education
-   Less than high school
-   High School graduate
-   Some college (no degree)
-   Non-Formal Education
-   Associate Degree
-   Bachelor's Degree
-   Master's Degree
-   Doctorate Degree

Age (Born in)
-   After 2012
-   1997 – 2012
-   1981 -1996
-   1965 -1980
-   1955 -1964
-   1946 -1954

Marital Status
-   Single
-   Married
-   Divorced
-   Separated
-   Widow or widower
-   Other

Primary Travel Purpose
-   Leisure/ Vacation
-   Business
-   Conference/training
-   Visiting family/friends
-   Academic/study
-   Other

Primary Travel
-   Individual
-   In a group
-   No Response

Frequency of Travel
-   1 – 3 Times a Week
-   More than 3 Times a Week
-   1-3 Times a Month
-   More than 3 Times a Month
-   Once a year
-   Twice a year
-   Never
-   No response

Frequent Flyer Program
(Ref. (Terblanche, 2015)
-   I use airline frequent flyer programs
-   I don't use airline frequent flyer programs
-   I use other company loyalty programs
-   I don't use other company loyalty programs

Voluntary Carbon Offsetting Program (VCOP) Ref. (Terblanche, 2015 and Mair, 2011)	COP1: I would purchase a carbon offset for a flight.	1	2	3	4	5
	COP2: I would give up my loyalty program points from any company to offset my travel emissions.	1	2	3	4	5

Scenarios

Introduction

We are going to kick this off with some basic science. Climate change is widely due to the increase in burning fossils fuels since the industrial revolution. Our population has also tripled in the past 70 years (UNFCCC, 2015), which has caused for larger production of these fossil fuels. These gases are released into the air, and as sunlight hits Earth's surface, some of the heat gets trapped, and the climate gets warmer, also known as the greenhouse effect. The average global temperature has increased by almost 1C since 1880 (Nunez et al., 2019). The 2015 Paris Agreement set forth a goal to keep global temperature increase below 2C (UNFCCC, 2015). Changes in the global temperature have led to regional changes in our climate and extreme natural disasters such as drought, flooding, wildfires, water shortages, and rising sea levels from glaciers melting. People are losing their homes, cities are flooding, islands are disappearing, and the worst is yet to occur (Busch and Judick, 2021). Scientists have referred to this catastrophe as the 6th mass extinction event.

Presently, aviation accounts for around 3.5% of global CO2 emissions (DLGR, 2021). Despite the airline's efforts in pursuing sustainable initiatives, the responsibility of the airline industry continues to grow due to rapid growth in airline travel (IATA, 2017). Voluntary carbon offsetting programs VCOP give eco-minded people the opportunity to compensate for their carbon emissions emitted while flying (Kerner and Brudermann, 2021). A carbon offset is an investment in a climate change mitigating project. The main idea behind VCOP is to compensate for as many carbon emissions caused by the initial action. This carbon-neutral idea would allow passengers to support airline programs that ensure they take the initiative to offset the emitted carbon of that person's flight. The offsetting carbon program we propose is giving back your frequent flyer miles to support many of the sustainable initiatives that airlines are set to achieve with a guaranteed promise your loyalty program rewards will be used for said project.

Please choose the region in which you reside to learn more about the changes in climate in your area. Every region is experiencing similar but different natural disasters, and we encourage you to learn about them all. Please feel free to read about all four regions but only select the one region you reside in.

Northeast: M.D., DE, NJ, CT, RI, MA, VT, PA, NY, NH, ME

Heat waves, sea-level rise, and cold air outbreaks pose a growing risk to the cities and towns in the Northeast (N.E.) (Horton et al., 2014). Sixty-four million people are living in the N.E. today. This area not only holds some of the most developed cities in the world but is home to leading financial centers, the nation's capital, and many defining historical landmarks. This area includes large cities and more than 180,000 farms that bring in $17 billion in annual sales (Horton et al., 2014).

One natural disaster that impacted the N.E. was Hurricane Irene, causing massive coastal damage, storm surge, and flooding along the N.E. coastline (Horton et al.). During its

impact, Irene produced two to three inches of rainfall per hour in certain areas in late August 2011. Natural disaster, Hurricane Sandy, followed in October 2012, becoming the second most costly Atlantic hurricane in history (Horton et al., 2012). In preparation for Hurricane Irene, New York City transportation was shut down, and over 2.3 million coastal residents were forced to evacuate (Horton et al., 2014). However, the most severe impacts were on the inland areas of upstate New York and central Vermont. Flash flooding wiped out roads and bridges, undermined railroads, brought down trees, powerlines, and buildings, flooded homes, and devastated ecosystems (Horton et al., 2014). In Vermont, over 500 miles of roadways were damaged, estimating $175 to $250 million in rebuilding costs (Horton et al., 2014). Residents suffered from mold growth in flooded homes and cleaning up spills from damaged waste tanks cost Vermont an estimated $1.75 million (Horton et al., 2014). Hurricane Irene took 41 lives, while Hurricane Sandy was responsible for 150 deaths. Sandy cost the Northeast between $60 to $80 billion in repairs. 8.5 million people were without power, and an estimated 650,000 homes were damaged after Hurricane Sandy (Horton et al., 2014). Projections and suspected vulnerabilities due to coastal flooding and sea levels rising have been available as early as 2001, and although these reports were around, the devastation was still a surprise to many residents.

Disruption to services interrupt commerce and threaten public health in safety in the N.E. In New York State alone, sea-level rise is estimated to flood or render unusable 2,112 miles of roads, 3,647 acres of airport facilities, and 539 acres of runways (Horton et al., 2014). The northeastern hurricanes, along with extreme winters, record-breaking heat waves, and flooding cities, are due to changes in the Earth's temperature from trapped CO_2 in our atmosphere. Carbon offsetting not only enables customers and airline passengers to invest in sustainability but also has the potential to decrease and prevent further natural disasters from occurring in your backyard.

Midwest: N.D., SD, NE, KS, MN, IA, MO, WI, IL, IN, MI, OH

Home to more than 61 million people, the Midwest (M.W.) has expansive agricultural lands, forests, lakes, and populous cities (Pryor et al., 2014). The relationship between people, ecosystems, and infrastructure is at risk with posing climate change. Increased heat stress, flooding, and drought will be multiplied by changes in pests and diseases from temperatures increasing and climates shifting (Pryor et al., 2014). Competition from native and non-native species, agriculture shocks from extreme natural disasters, and landscape changes, when taken collectively, are projected to alter the socioeconomic patterns and ecosystems of the M.W. The Great Lakes and northern forest are major supplies to fisheries, recreation, tourism, and commerce in the M.W.

The concern with living in the M.W. in the upcoming years is increased heat wave intensity and frequency, leading to increased humidity, degraded air quality, and reduced water quality affecting public health (Pryor et al., 2014). The frequency of major heat waves has increased over the last six decades in the M.W. (Pryor et al., 2014). Within the United States, we see mortality increase by 4% during heatwave days compared with non-heat wave days (Anderson and Bell, 2011). On July 20th, 2011, the majority of the M.W. experienced temperatures over 100F, and for most of that summer, the citizens were under a heat alert (Anderson and Bell, 2011). Studies predict that there will be an increase of up to 2,217 excess

deaths per year due to heat stress in Chicago alone by 2081 (Pryor et al., 2014). Air quality in most of the M.W. fails to meet the national ambient air quality standards due to induced emissions and increased pollen season, which is predicted to amplify during higher temperatures (Pryor et al., 2014). Increased temperatures also correlate to increased diseases and higher amounts of disease carriers like insects and rodents (Pryor et al., 2014).

The M.W. is also characterized by a rich and diverse forest full of natural ecosystems, wetlands, and native species (Pryor et al., 2014). Global carbon absorbers, such as these forests, are at risk of not intake as much carbon and store it from disturbances in insect outbreaks, fires, and droughts from heatwaves. M.W. forests are an amazing absorber of carbon dioxide (CO_2) and absorb more CO_2 than they emit (Pryor et al., 2014). With changes in weather patterns causing record-breaking high temperatures, insect outbreaks, and increased humidity, this area might soon be changed from a carbon absorber to a carbon-emitting region (Pryor et al., 2014). Planting trees is one method of carbon offsetting available for the aviation industry. Taking in carbon and allowing these forests to be under less stress enables all the ecosystems in the M.W. to breathe and work on adapting to higher temperatures. Carbon offsetting not only enables customers and airline passengers to invest in sustainability but also has the potential to decrease and prevent further natural disasters, drought, and starvation from occurring in your backyard.

South: V.A., WV, KY, TN, GA, NC, SC, FL, AL, MS, LA, AR, OK, TX

From the Appalachian Mountains to the coastal plains, this area is home to more than 80 million people and draws in millions of visitors each year (Carter et al., 2014). The Gulf and Atlantic coasts are major producers of seafood, home to seven large ports, and are extremely vulnerable to sea-level rise. The number of category 4 and 5 hurricanes has increased substantially since the early 1980s, and in recent years the World Meteorological Organization has run out of phonetic alphabet names and had to use the Greek alphabet to name the remainder of the hurricanes in those years (Carter et al., 2014). Water resources in the Southeast (S.E.) are abundant and support the various populated cities, rural communities, and unique ecosystems (Carter et al., 2014). Water conflicts due to drought have occurred between states, such as the 2007 drought in Atlanta, Georgia (Carter et al., 2014). One major concern noted in the S.E. is reduced water availability in the upcoming years due to increased evaporation from rising temperatures. With the projected increase in population in the S.E., the continued development of the urbanized area will increase these citizens' water needs and potentially threaten freshwater qualifiers by exacerbating saltwater during urbanization. Higher sea levels will accelerate saltwater intrusion into freshwater supplies like rivers, streams, and wells. City officials in Hallandale Beach, Florida, have already announced the abandonment of six of their eight drinking water wells (Berry et al., 2011). Water demand is already needed to increase from an increase in demand for food and agricultural production due to the population increase in the S.E. With a concern of limited water availability already happening, a plan is needed to protect the citizens of the S.E. from protecting them against their human right to clean drinking water.

Rising air and sea surface temperatures, variability in precipitation patterns, increased storms and hurricanes, and impact on water availability also made food security a major concern for the S.E. (Lincoln et al., 2021). Food security is the state in which people, at all times, have access to sufficient, safe, and nutritious food to meet dietary needs for a healthy life (Lincoln et al., 2021). Declines in fisheries, from impacts on ports in the S.E., are a cause for concern about

climate change in this region. Mild water deficits can create reduced growth rate, fertilization issues, and overall reduced fruit yield for many farmers in the S.E. The main threat noticed to meat production is heat stress, which decreases animals' productivity, fertility, ability to gain weight, and increases the risk of diseases (Lincoln et al., 2021). Communities that are dependent on fisheries are at risk of having vulnerable fish begin to reproduce less, due to warming ocean temperatures (Lincoln et al., 2021). Food security and increased demand for water are directly related to changes within our southeastern ecosystem. Temperature increase caused by carbon emissions has already shown signs of a War on food and water in the S.E. Carbon offsetting not only enables customers and airline passengers to invest in sustainability but also has the potential to decrease and prevent further natural disasters, drought, and starvation from occurring in your backyard.

West: A.K., HI, WA, OR, MT, ID, WY, CO, UT, NV, CA, AZ, NM

The southwest S.W. is the hottest and driest region in the United States, while the northwest N.W. has a complex climate including snow-packed mountains, fires, and volcanic activity. Granted their differences, the combined impacts of increasing wildfires in both areas are already causing widespread tree die-off and long-term forest landscape transformations (Mote et al., 2014). In the southwestern region, not only do these wildfires pose a threat to the public, but amplified heat causes disruptions to urban electricity and water supplies (Garfin et al., 2014).

Increased wildfire risk will alter N.W. forests and increase tree disease outbreaks caused by climate change (Mote et al., 2014). Relative to the 1916 to 2007 period, by the 2080's the median annual area burned is expected to quadruple to two million acres (Mote et al., 2014). Pine mortality has already increased from a spike in the mountain pine beetle which increases with warmer temperatures (Mote et al., 2014). Increased wildfires are expected to have health consequences by exacerbating respiratory and cardiovascular illnesses in cities that surround these forests. The N.W. economy can see significant impacts from local timber revenues decreasing (Mote et al., 2014).

The S.W. has the highest percentage of its population living in cities and its urban population rate is 12% greater than the national average (Garfin et al., 2014). These urban infrastructures are vulnerable more than normal because of their interdependence, meaning strains in one system can cause disruptions in another (Garfin et al., 2014). To deal with high temperatures, extensive air conditioning can quickly increase the electricity demand and trigger energy system failure or result in blackouts where the city shuts down the power grid. Heat stress is already a reoccurring problem for urban residents. As temperatures are expected to increase, if nothing is done to improve the electricity grid, rolling blackouts could be expected to occur much longer. Wildfires brought on by these excessive high-temperature days, create human respiratory issues, reduce air quality from chemical reactions occurring faster, and more disease (Garfin et al., 2014). These warm seasons are expected to be longer as years go on in the N.W. and S.W. Without changes to our day-to-day sustainable behaviors, reduction in CO2, and education about climate change, the path that the S.W. and N.W. are on is not easy or safe. Carbon offsetting not only enables customers and airline passengers to invest in sustainability but also has the potential to decrease and prevent further natural disasters, drought, and starvation from occurring in your backyard.