

Final Report MPP 2021-2022

Project Title:

Climate Change: Beliefs and Social Consequences in Portugal

Research Area(s):

[Climate Science & Climate Change \(Area 1\)](#)

[Sustainable Cities \(Area 4\)](#)

MIT Principal Investigator:

Siqi Zheng, Samuel Tak Lee Professor of Urban and Real Estate Sustainability, MIT Department of Urban Studies and Planning, and Center for Real Estate; Faculty Director, MIT Sustainable Urbanization Lab

Research Team and Collaborations:

MIT:

- Dr. Juan Palacios (jpalacio@mit.edu), Research Associate and Head of Research, Sustainable Urbanization Lab, MIT
- Nicolas Guetta-Jeanrenaud (nicogj@mit.edu), Graduate student in Technology & Policy, MIT Institute for Data, Systems, and Society, and Sustainable Urbanization Lab, MIT

Collaborator team in Portugal:

- Prof. Miguel de Castro Neto (mneto@novaims.unl.pt), Assistant Professor and Associate Dean at NOVA Information Management School (NOVA IMS). He is also the coordinator of NOVA Cidade Urban Analytics Lab, a network of scientists and professionals for the creation and transfer of knowledge in urban intelligence, smart and sustainable cities and territories.
- Fatima Nieves, researcher at NOVA Information Management School (NOVA IMS)
- Mauro Ricardo Fernandes Pereira, researcher at NOVA Information Management School (NOVA IMS)

Accomplishments and results of the project

During the academic year 2021-2022, the MIT Portugal Seed grant enabled the MIT Sustainable Urbanization Lab led by Prof. Siqi Zheng to work with the team at NOVA Information Management School led by Prof. Miguel Neto to design and implement the first algorithm that connects social media sentiment data with local house prices. The team developed an application of the method to the Portuguese real estate market. In the following paragraphs, we develop a description of the main milestones and products that have been achieved during the grant period.

Production of Sentiment Dataset from Billions of Geotagged Tweets Using Natural Language

Tools

The MIT Sustainable Urbanization Lab has created a global database pairing natural language techniques of sentiment analysis with billions of geotagged tweets to evaluate the level of expressed well-being in each. This database enables researchers to estimate the impacts on expressed well-being associated with numerous shocks (e.g. COVID-19 outbreaks, lockdowns, local air pollution shocks, etc.).

The description of this database has been described in a new manuscript, recently submitted to the journal *Scientific Data*, where it is under review (Chai et al., 2022). Aggregated indices of sentiment at the national and regional level will be made available for research purposes (link to online portal [here](#)).

Abstract:

Promoting well-being is one of the key targets of the Sustainable Development Goals at the United Nations. Many national and city governments worldwide are incorporating subjective well-being (SWB) indicators into their agenda, to complement traditional objective development and economic metrics. In this study, we develop the Twitter sentiment geographical index (TSGI), a comprehensive archive proxying SWB by applying natural language processing techniques on 7.4 billion geotagged tweets, posted from 2012 to the present. In contrast to the previous works focusing on the SWB, TSGI is not limited to a specific topic, period, or location. Using this data, we construct a high-frequency multi-year database that has global coverage, which enables the evaluation of SWB in 163 countries and regions for one decade. Finally, we provide a website platform where researchers can access the national indices, updated monthly with new data.

Citation: Chai, Kakkar, Palacios & Zheng (2022), "Twitter Sentiment Geographical Index"

Development of Sentiment Damage Indices Associated with Extreme Temperature

In the second phase project, we developed an econometric model to link extreme temperatures to sentiment, using the database described in the previous subsections. This method allows to compute the magnitude of expressed sentiment changes in over 100 countries when they have days that are extremely hot or extremely cold. The description of the algorithm are described in a manuscript, submitted to Nature Climate Change where is currently under review (Wang et al., 2022). Abstract is included below:

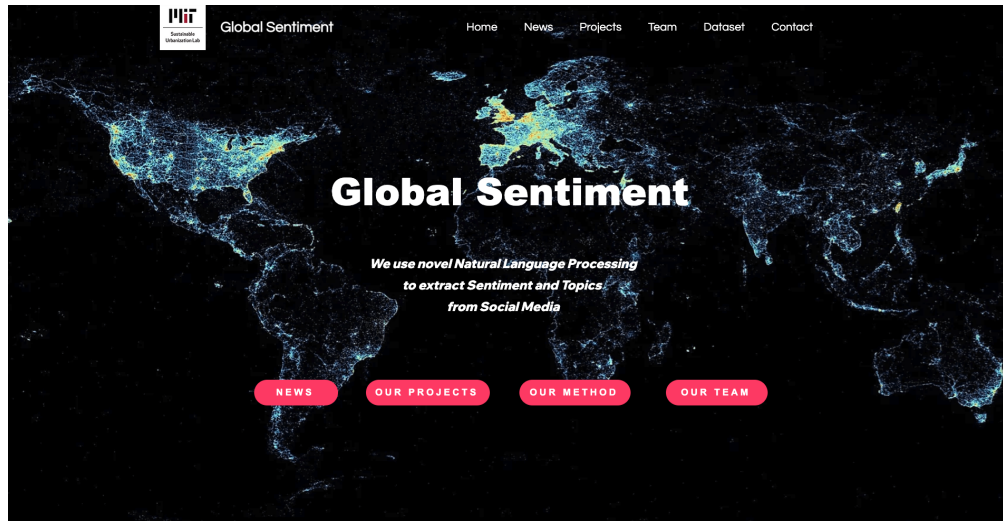
Estimating the potential impact of climate change on human emotional well-being is a critical component of understanding the manners in which future climatic changes may undermine human mental health. Existing studies on this topic center primarily on economically wealthy and data-rich societies. However, the ways that climatic factors affect rich nations may differ substantially from how those same factors affect those in poorer nations. Here, we employ over 1.2 billion social media posts from 157 countries worldwide, covering over 95% of the global population, coupled with daily variation in temperature and related meteorological conditions to estimate how sentiment changes in response to ambient temperatures. To do so, we employ multilingual natural language processing to quantify the expressed sentiment in over 65 identifiable languages across a global sample of social media. Our causal analysis based on climate econometrics tools suggest that, at the global level, ambient daily maximum temperatures above 35 °C lead to an average reduction in the sentiment score of 18.2% of a standard deviation (95% confidence interval: 17.3%-19.1%), compared with reference temperatures of 15°C-20°C. We find that extreme temperatures lead to statistically significant sentiment drops in over 110 countries across the world, particularly larger in medium-to-low development regions. We project that climate-change-induced warming could further reduce individuals' sentiment by 4.5% (95% confidence interval: 3.2%-5.6%) by the end of this century. These findings provide additional evidence that climate change may harm human mental well-being via effects on day-to-day sentiments and emotions, that in turn may cumulate into more severe mental health impacts.

Citation: Wang, Guetta, Palacios, Fan, Kakkar, Ovradovich & Zheng (2022) "A global nonlinear effect of temperature on human sentiment"

MIT SUL Global Sentiment Website

The MIT Sustainable Urbanization Lab developed a new website (www.globalsentiment.mit.edu) where we share with researchers and other interested parties, visualizations and aggregated indices part of the Global Sentiment Project supported by MIT Portugal Seed Funds. The support

of the MIT Portugal Seed Fund supported the team that was dedicated in the design and infrastructure development of the website. We include below an screenshot of the website:



Using Sentiment Damages to Predict Local House Prices

The MIT Sustainable Urbanization Lab and the NOVA team have developed an algorithm that connects city level sentiment damages associated with extreme weather to the local house prices in Portugal. The team at NOVA collected the real estate data from the Confidencial Imobiliário real estate portal. The results and methods are included in the manuscript Guetta et al., (2022). This manuscript is in the second round of revision in the journal *Cities*.

As anthropogenic climate change disrupts cities worldwide, increasingly severe weather events and temperature discomfort pose potential harm to location attractiveness, and therefore to real estate value. However, the extent to which climate events affect markets depends highly on the subjective perception of these events by local inhabitants. This study proposes a model examining the impacts of temperature stress on real estate value which incorporates subjective measures of these climate events, in the form of a social media-based sentiment-damage coefficient. We run an empirical study in the largest metropolitan areas of Portugal, and find that temperature discomfort has a significant, negative impact on housing prices. Sentiment damages moderate the magnitude of price drops in real estate. Municipalities with the strongest subjective sentiment reactions to temperature discomfort also witness the sharpest drops in real

estate value. These results reinforce the importance of including subjective perceptions when assessing the impacts of climate change, and the relevance of social media data to do so.

Citation: Guetta, Nieves, Fernandes, Palacios, Neto & Zheng (2022) "Climate risk, sentiment, and real estate value: Social media-based findings in Portugal"

Interactions between MIT Sustainable Lab group and NOVA group

Biweekly meetings

Over the entire seed fund, the MIT Sustainable Urbanization Lab and NOVA had biweekly meetings to develop the co-authored manuscript, and keep each other updated over the entire grant period. In these meetings, all members of the team were regularly present.

Joint Seminars

The two groups provided joint seminars at MIT where we received critical feedback to improve the manuscript before the submission to the journal.

Co-authored manuscript

Over the spring semester of the academic year 2022-2023, the two teams worked together in the development of a joint manuscript using social media data and sentiment analysis to understand the price drops in house prices associated with extreme weather events.

The teams are still in close contact during the revision process, and committed to keep working on the project until the manuscript is published.