

2022

CGA Virtual Forum

THE UNEVEN GEOGRAPHY OF CLIMATE CHANGE

May 20, 2022



Center for
Geographic Analysis
Harvard University



IQSS
The Institute for Quantitative Social Science



Center for Spatiotemporal Thinking,
Computing, and Applications (STC)
George Mason University

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While a changing climate impacts everyone's ability to feed and support themselves, these impacts are not experienced equally. The uneven geography of climate change is revealed as grassroots movements and industrialized nations around the world take action. Farmers in India demonstrated in late 2021 that radical and inclusive democratic mobilization can be a force for foundational change in agricultural policies. Their protests and legislative victories came as COP26 concluded with a new resolve to address greenhouse gas emissions, driven by the now obvious and urgent impacts of a warming climate on the globe's most vulnerable populations and places. Whether borne of these movements or top-down directives, actions to address climate change must react to and target the unevenness of its effects. What is the geography of climate change? How is this unevenness shaping and distorting attitudes and responses? How might the tools of geography lead to a better understanding?

In this virtual forum, invited speakers and registered attendees will explore the uneven geography of climate change while surveying data and technology that can advance our understanding of these various inequities. We look to examine geographic perspectives on policies, conflicts, disasters, population movements, predictions, models, and other spatially modulated climate effects. We plan to highlight tools that provide insights on geographic changes in climate parameters as well as changes in attitudes and perceptions. We will consider opportunities provided by high performance computing and the use of big data. Discussions will target methods to measure impacts at the human scale, and analytical approaches attuned to questions of climate equity within and between nations, whether social or economic, across racial and ethnic divides, or along dimensions of personal, family, and community health.

Program

Friday, May 20, 2022, 10:30AM - 12:30PM (EDT)

| Begin | End | Duration | Topic | Speaker | Organization |
|----------|----------|----------|---|--|---|
| 10:30 AM | 10:35 AM | 0:05 | Welcome & Introduction | S V Subramanian | Harvard CGA & HSPH |
| 10:35 AM | 10:50 AM | 0:15 | Spatial Inequalities in Climate-Sensitive Hazard Impacts | Susan Cutter | University of South Carolina |
| 10:50 AM | 11:05 AM | 0:15 | The Extreme - Weather Climate Gap: Implications at the intersection of risk and vulnerability | Marshall Shepherd | University of Georgia |
| 11:05 AM | 11:20 AM | 0:15 | What is known about the geography of solar geoengineering's risks and benefits | David Keith | Harvard HKS & SEAS |
| 11:20 AM | 11:35 AM | 0:15 | Climate Change and Global Sentiment | Siqi Zheng | MIT |
| 11:35 AM | 11:40 AM | 0:05 | Unlocking Geospatial Big Data for Climate Change Research using High-Performance Computing | Devika Kakkar | Harvard CGA |
| 11:40 AM | 11:45 AM | 0:05 | Climate Mapping for Cultural Heritage | Pam Hatchfield | Held in Trust |
| 11:45 AM | 11:50 AM | 0:05 | International Public Opinion on Climate Change | Kelsey Mulcahy | Meta (Facebook) |
| 11:50 AM | 11:55 AM | 0:05 | Tracking human responses to climate impacts with NASA's Black Marble | Eleanor (Kellie) Stokes | Earth from Space Institute, USRA, NASA GESTAR |
| 11:55 AM | 12:25 PM | 0:30 | Panel Discussion | Matt Wilson & Doug Richardson (Moderators) | UKY & Harvard CGA |
| 12:25 PM | 12:30 PM | 0:05 | Closing remarks | Doug Richardson | Harvard CGA |

Register in advance for this webinar: <https://harvard.zoom.us/j/93276080996>

After registering, you will receive a confirmation email containing information about joining the webinar.

This event is hosted by the [Center for Geographic Analysis](#), a member of the [Institute for Quantitative Social Science](#) at Harvard University, and co-sponsored by the NSF IUCRC [Spatiotemporal Innovation Center](#) (Award numbers 1841403 and 1841520).

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Abstracts and Biography

Opening Remarks: Welcome and Introduction

Subu Subramanian (Harvard University)



Dr. S (Subu) V Subramanian is Professor of Population Health and Geography at Harvard University. He was the Founding Director of Graduate Studies for the interdisciplinary PhD program in Population Health Sciences at Harvard. He has published over 700 articles, book chapters, and books in the field of social and contextual determinants of population health, determinants of health inequalities in India, and applied multilevel statistical models. He has consistently been included in the Highly Cited Researchers (top 1% of cited publications in Web of Science) list since 2015. Subramanian is the Co-Editor-in-Chief for the international journal *Social Science & Medicine* (SSM), a Co-Senior Editor for the social epidemiology office of SSM, and the founding Co-Editor-in-Chief of a new journal *SSM – Population Health*, winner of the 2020 PROSE Award for Best New Journal in Social Sciences.

Spatial Inequalities in Climate-Sensitive Hazard Impacts

Susan Cutter (University of South Carolina)

Abstract: *Inequalities in disaster risk occur from local to global scales. Disaster losses and impacts are increasing, especially in the U.S. and continue to disproportionately affect the most disadvantaged in society. Using bivariate mapping, the spatial patterns of county-level economic (property and crop) losses and pre-existing conditions of social vulnerability highlight counties with the most vulnerable populations and the greatest need for post-disaster assistance and recovery resources. The geospatial approach provides an apolitical mechanism for prioritizing disaster recovery resources to achieve a more equitable outcome for the most vulnerable and most in need. The successful application of this approach for South Carolina's recent disaster declarations (2015-17) illustrates the translation of geographical science into evidentiary-based practice and policy to ensure greater equity in state and federal allocations of disaster recovery resources.*



Dr. Susan Cutter is a Carolina Distinguished Professor of Geography at the University of South Carolina and director of the Hazards Vulnerability and Resilience Institute (HVRI). She has authored or edited 15 books, 150+ plus peer-reviewed articles and book chapters and mentored more than 60 masters and doctoral candidates. Her research focusses on disaster vulnerability and resilience science with specific reference to methods, models, and metrics. Her scientific contributions include the hazards of place model of vulnerability, the disaster resilience of place (DROP) model, as well as tools for assessing spatial and temporal variability in vulnerability (Social Vulnerability Index or SoVI®) and resilience (Baseline Resilience Indicators for Communities [BRIC] Index). Her policy-relevant work focuses on the evidentiary basis for hazard mitigation and disaster recovery policy and practice at local, state, national, and international levels. In particular, she continues to lead investigations of the disproportionate spatial and temporal impacts of

disasters on vulnerable populations and the places where they live. Dr. Cutter is an elected fellow of American Association for the Advancement of Science (AAAS). She received an honorary doctorate from the Norwegian University of Science and Technology (2015) and elected as a foreign member of the Royal Norwegian Society of Sciences and Letters. She was also the recipient of her discipline's highest awards: American Association of Geographers (AAG) Lifetime Achievement, Presidential Achievement, and the Wilbanks Award for Transformational Research.

The Extreme - Weather Climate Gap: Implications at the intersection of risk and vulnerability Marshall Shepherd (University of Georgia)

Abstract: *Climate change "DNA" is clearly apparent in current extreme weather events. While exposure to these events is often the equal, sensitivity and resiliency can vary for communities of color, the elderly, and impoverished groups. Using an accessible approach, Dr. Shepherd uses a contemporary lens, scientific literature and personal perspectives to explore how the emerging climate and its associated weather will affect community vulnerability.*



Dr. J. Marshall Shepherd is a leading international weather-climate expert and is the Georgia Athletic Association Distinguished Professor of Geography and Atmospheric Sciences at the University of Georgia. He was the 2013 President of American Meteorological Society (AMS). Dr. Shepherd serves as Director of the University of Georgia's Atmospheric Sciences Program, the Associate Director of Climate and Outreach for the Institute for Resilient Infrastructure Systems, and Full Professor in the Department of Geography where he was a previous Associate Department Head. Dr. Shepherd is also the host of The Weather Channel's Award-Winning Weather Geeks, a pioneering TV talk show/podcast and is a Senior Contributor to Forbes Magazine. In 2021, Dr. Shepherd was elected to the National

Academy of Sciences, National Academy of Engineering, and the American Academy of Arts and Sciences. He also received the Friends of the Planet Award from the National Council of Science Educators and the American Geological Institutes Award for Engagement in the Geosciences. Georgia Trend magazine recognized him as one of the 100 Most Influential Georgians in 2022. Dr. Shepherd is the 2020 Recipient of the Mani L. Bhaumik Award for Public Engagement with Science from the American Association for the Advancement of Science, the 2019 Recipient of the AGU Climate Communication Prize and the 2018 recipient of the prestigious AMS Helmut Landsberg Award for pioneering and significant work in urban climate.

What is known about the geography of solar geoengineering's risks and benefits David Keith (Harvard University)

Abstract: *The divergence of expert opinion about solar geoengineering (SG) may be sharper than in any other area of climate policy. As with other contested technologies, disagreement sometimes conflates divergent scientific and political judgments with divergent normative stances. SG is perhaps best defined in relation to other ways of managing climate risk; it is one of four toolboxes: emissions reduction, carbon removal, SG, and adaptation. This presentation explores what is known about the geography of solar geoengineering's risks and benefits.*



Dr. David Keith has worked near the interface between climate science, energy technology, and public policy for twenty-five years. He took first prize in Canada's national physics prize exam, won MIT's prize for excellence in experimental physics, and was one of TIME magazine's Heroes of the Environment. David is Professor of Applied Physics at the Harvard School of Engineering and Applied Sciences and Professor of Public Policy at the Harvard Kennedy School, and founder of Carbon Engineering, a company developing technology to capture CO₂ from ambient air to make carbon-neutral hydrocarbon fuels. Best known for his work on the science, technology, and public policy of solar geoengineering,

David led the development of Harvard's Solar Geoengineering Research Program, a Harvard-wide interfaculty research initiative. His work has ranged from the climatic impacts of large-scale wind power to an early critique of the prospects for hydrogen fuel.

Climate Change and Global Sentiment

Siqi Zheng (MIT)

Abstract: *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. In our "Climate Change and Global Sentiment" project, we employ over 1.2 billion social media posts from 157 countries worldwide, covering over 95% of the global population, coupled with daily fluctuations in temperature and related meteorological conditions to estimate how sentiment changes in response to extreme temperatures. Our findings lend additional evidence that climate change may produce harm to human mental well-being via effects on day-to-day sentiments and emotions that in turn may cumulate into more severe mental health impacts. Understanding how such psychological factors interrelate is critical to properly targeting effective adaptation and resilience policies.*



Dr. Siqi Zheng is the STL Champion Professor of Urban and Real Estate Sustainability at the Center for Real Estate, and Department of Urban Studies and Planning at Massachusetts Institute of Technology (MIT). She is the faculty director of the MIT Center for Real Estate. She established MIT Sustainable Urbanization Lab in 2019, and MIT China Future City Lab in 2017, and is the faculty director of her Lab. Prof. Zheng's field of specialization is urban and environmental economics and policy, including environmental sustainability, and place-based policies and self-sustaining urban growth. She published in many peer reviewed international journals including the Proceedings of the National Academy of

Sciences, Nature Human Behaviour, and the Journal of Economic Literature. Dr. Zheng has completed or been undertaking research projects granted or entrusted by the World Bank, the Asian Development Bank, the Lincoln Institute of Land Policy, the National Natural Science Foundation of China, among others.

Unlocking Geospatial Big Data for Climate Change Research using High-Performance Computing

Devika Kakkar (Harvard University)

Abstract: *Climate change researchers are increasingly working with large geospatial datasets that contain hundreds of millions of records. At this scale, there are challenges of data storage, extraction, analysis and computation. This talk will discuss two use cases of unlocking the value of geospatial big data for climate change research by using High-Performance Computing and GIS Data Science. The first use case involved the use of advanced Machine Learning techniques and GPU databases to enrich a dataset of 10 billion Geotweets. This enriched dataset was used to study the effects of extreme temperatures on human sentiment. The second use case describes the use of spatial databases and cluster computing to extract address level climate variables from the PRISM 800 meter resolution climate dataset over a 20 year period. The resultant dataset of 10 million patient-days of calculations with over 90 million observations enabled researchers to study the effect of disparate climate related environmental exposures at the cohort address locations over time.*



Devika Kakkar is a Project Manager at CGA where she leads the GIS Data Science and Big Data workstream. She has 10+ years of experience in GIS, data science and software development. Before joining CGA in 2016, she worked as a Researcher with Fraunhofer IIS, Germany and London School of Economics, UK. She holds a Master's degree in Geodesy and Geoinformation Science from Technical University Berlin, Germany and a Bachelors in Civil Engineering from HBTI, India.

Climate Mapping for Cultural Heritage

Pamela Hatchfield (Held in Trust)

Abstract: *Held in Trust, a collaboration between the National Endowment for Humanities and the Foundation for Advancement in Conservation, examines existing infrastructure, challenges and opportunities in the preservation and conservation of cultural heritage, with the intent of establishing a forward-looking vision for the future. The project focuses on the intersection of preservation with critical areas of study, including environmental resilience, science and technology, inclusivity, equity, and collaboration in professional practice and education. In exploring the landscape of the field, it is clear that custodians of cultural heritage resources (sites, built heritage, collections and communities) urgently require tools to understand risks, determine priorities, and build resilience in the face of threats posed by climate change. Held in Trust recommended the development of a new project to compile maps of cultural heritage resources overlaid with specific climate risk exposure maps. Understanding the specific nature and level of risk from hazards such as fire, heat, drought, flooding and erosion to cultural heritage resources will allow the informed development of climate action plans based on reliable and current data. The proposed development of such maps, possible dissemination and implementation methods, and methodologies to promote community involvement will be discussed.*



Pamela Hatchfield serves as Project Coordinator for Held in Trust, a collaboration between the Foundation for Advancement in Conservation and the National Endowment for Humanities. The project evaluates the present state and future directions of preservation and conservation of cultural heritage in the United States. She is also the Robert P. and Carol T. Henderson Head of Objects Conservation Emerita at the Museum of Fine Arts, Boston, where she worked for more than 35 years. She holds a B.A. from Vassar College and graduate degrees in Art History and Conservation from the Institute of Fine Arts, New York University, with post graduate work at the Straus Center for Conservation at Harvard University. Her conservation experience includes the Metropolitan Museum of Art, several Smithsonian Institution Museums, and the Grenada National Museum in the West Indies. Pam serves as a consultant to New York University’s Acton Collection at Villa La Pietra in Florence, Italy. Her archaeological field experience includes sites Egypt and Sudan. Pam is a Fellow of the International Institute for Conservation, the American Institute for Conservation, and the American Academy in Rome, and received the Robert L. Feller Lifetime Achievement Award from AIC in 2021.

International Public Opinion on Climate Change

Kelsey Mulcahy (Meta)

Abstract: *Data for Good at Meta shares privacy preserving data products to help strengthen communities and advance social issues by leveraging the scale of the Facebook platform. In partnership with the Yale Program on Climate Change Communication, Data for Good at Meta released a new dataset and findings from the 2021 Climate Change Opinion Survey to support research on climate change. These datasets can help provide non-profits, decision-makers, and the public with an understanding of public views on climate change across 31 countries, including knowledge, attitudes, policy preferences, behaviors, and more.*



Kelsey Mulcahy is a Public Policy Research Manager on Meta’s Data for Good team. She helps build privacy-preserving datasets to help strengthen communities and advance social issues. She currently leads Data for Good’s surveys work, including the sharing of information to support partner efforts related to covid-19, economic opportunity, and climate change. Previously, Kelsey managed Facebook’s social science research partnerships with academia and led an open science initiative at UC Berkeley. She holds a BA in Global Studies from UCSB and MA in Public Policy from UCLA.

Tracking human responses to climate impacts with NASA’s Black Marble

Eleanor Stokes (Earth from Space Institute)

Abstract: *With climate change, associated changes in the intensity, frequency, duration, timing, and location of weather and weather extremes are expected, upsetting the way of life for many communities. In the satellite*

record, the distribution of impacts of climate change are largely monitored through bio-physical variables. Meanwhile, the impact on social systems has been more difficult to capture through remote sensing and relied heavily on surveys and other types of big data. In this lightning talk, we highlight recent research using nighttime satellite data to track changes in our Human Planet – from disasters, conflict, and population movements. We showcase how NASA’s Black Marble Product Suite has provided insights into the geographic heterogeneity of climate impacts, and how future advances in nighttime monitoring may further illuminate the human processes shaping the Earth.



Dr. Eleanor Stokes serves as a senior scientist at the Earth from Space Institute (EfSI), housed at Universities Space Research Association. Stokes oversees fundamental natural and social science research activities at EfSI aimed at understanding planetary human-environment interactions. She also leads mission concept development and scientific research activities for NASA’s Black Marble, a team that was recently awarded the 2020 NASA Group Achievement Award. Prior to joining USRA, Stokes acted as a remote sensing and urban land scientist at NASA’s Goddard Space Flight Center, conducting research on urbanization and urban sustainability. She was awarded a NASA Jenkins fellowship and was

a pioneer user of Suomi-NPP VIIRS Day/Night Visible Band data, refining the early processing algorithms and developing novel methods to track urbanization dynamics. In 2020, she was chosen as one of ESRI’s “Women Stars of Spatial Science” and in 2021 one of GeoSpatial World 50 Rising Stars. She received a PhD from Yale’s School of the Environment, an MS in mechanical engineering at MIT, and a BA in studio art and mathematics from Dartmouth College.

Closing Remarks

Douglas Richardson (Harvard University)



Dr. Douglas Richardson is Distinguished Researcher at CGA. Before joining the CGA, he was the Executive Director of the American Association of Geographers (AAG) from 2003-2019, where he led a highly successful renewal of the organization. He greatly expanded its membership and international footprint, developed dynamic and wide-ranging new research initiatives, and built strong academic, publishing, and financial foundations for the AAG, and for geography’s future. Prior to joining the AAG, Dr. Richardson founded and was the president of GeoResearch, Inc., a scientific research firm that developed and patented the world’s first real-time space-time interactive GPS/GIS functionality, which has

transformed the ways in which geospatial data and geographic information is now collected, experienced, mapped, and used within geography and other disciplines, and in society at large. The concepts, technologies and innovations pioneered by Richardson and GeoResearch are now ubiquitous and at the heart of a wide array of real-time interactive mapping, navigation, mobile computing and consumer devices such as cell phones, and location-based business applications. They also have become central to the real-time management of day-to-day core operations of large-scale governmental

entities, corporations, and international NGOs. Richardson sold his company and its core patents in 1998, and has since continued to develop the field of real-time space-time integration in geography and GIScience through international and interdisciplinary geospatial research in areas such as health, sustainable environmental and economic development, human rights, coupled human-natural systems, and more recently the integration of spatial concepts, data, and analysis in the humanities and social sciences.

Panel Moderator

Matt Wilson (University of Kentucky & Harvard University)



Dr. Matthew W. Wilson is Associate Professor of Geography at the University of Kentucky and Visiting Scholar at the Center for Geographic Analysis at Harvard University. He co-founded and co-directs the New Mappings Collaboratory which studies and facilitates new engagements with geographic representation. He is co-editor of *Understanding Spatial Media*, published by SAGE, and his most recent book is *New Lines*, published with the University of Minnesota Press. He has previously taught at the Harvard Graduate School of Design, and his current research examines mid-20th century, digital mapping practices.

A banner for the Climate Change Service Pilot. The background is a green-tinted image of the Earth from space. The text is white and reads: "Climate Change Service Pilot" in large font, followed by "Enabling FAIR Standards" in a smaller font. In the bottom left corner, there is a blue URL: <https://www.ogc.org/projects/initiatives/ccspilot>. In the bottom right corner, there is the logo for the Open Geospatial Consortium, which consists of a stylized cube icon and the text "Open Geospatial Consortium".

<https://www.ogc.org/projects/initiatives/ccspilot>

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