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Viewpoint

How Climate Literacy and Public Opinion Are the Driving Forces Behind Climate-Based Policy: A Student Perspective on COP27

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Cite This: *ACS Omega* 2023, 8, 4430−4435

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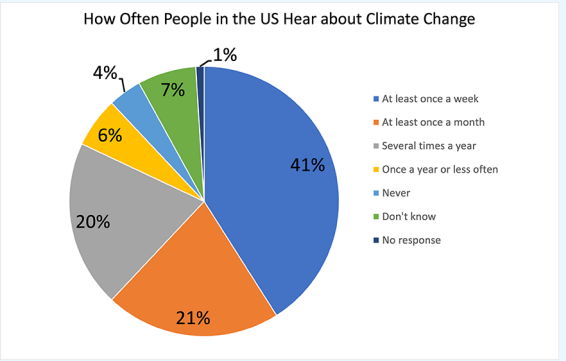
ABSTRACT: Despite the existence of a substantial amount of climate-related scientific data, misconceptions about climate change are still prevalent within public opinion. Dissemination of misinformation to the public through subjective media sources is a major challenge that climate scientists face. Implementation of climate policy is crucial for mitigation and adaptation measures required to curtail anthropogenic rooted climate change. This paper will discuss student perspectives on the 2022 United Nations climate summit in Egypt (COP27) related to climate literacy and public opinion as the driving forces behind the enactment and execution of important climate-based policy.



COP27

On November 7th, 2022, the United Nations Framework Convention on Climate Change (UNFCCC) 27th Conference of the Parties (COP27) kicked off in Sharm El-Sheikh, Egypt, where participants from all over the globe assembled to discuss ongoing mitigation strategies. Countries, territories, indigenous peoples, and observer organizations, both intergovernmental and non-governmental, sent accredited delegations to represent their climate-driven interests. Among the 45,000 attendees were student delegation members from the American Chemical Society (ACS), pictured in the photo collage in Figure 1. They attended various discussion sessions, country and organization pavilion events, plenary sessions, and world leader negotiations to ultimately learn how the various stakeholders are working towards realizing mitigation and adaptation strategies on an international scale. Each day at COP highlighted an overall theme that encompassed climate-based focal areas such as energy, finance, just transition, water security, and more to facilitate a broader discourse among attendees. The overarching theme of COP27 was climate implementation. However, the outcome did not rise to the lofty theme. Due to the underwhelming number of climate-based commitments made by the world's political leaders, there remains a significant amount of work to be done within the global climate space.

Decades of scientific data has led the world to understand that global climate change is dominantly driven by human-induced CO_2 emissions. Anthropogenic activities contribute the bulk of new CO_2 being dumped into the atmosphere on an annual basis, collectively equaling approximately 38 billion tonnes.[1] The effects of climate change can be identified through drastic changes in weather patterns and storm severity, rise in sea levels, threats to ecosystems, and deterioration of human health. Scientific predictions have long since made it apparent that inaction is not an option. In 2015, world leaders made significant headway *via* negotiations at the COP21 World Leaders Summit. During which, 196 nations agreed to respective 2030 greenhouse gas (GHG) emission targets to hold the average global temperature rise from pre-industrial temperatures to well below +2.0 °C, and pursue efforts to limit the rise to +1.5 °C, by 2100 in a landmark document known as the Paris Agreement. Since COP21, the only other major climate change agreement has been the Glasgow Climate Pact from COP26, where nations agreed to reduce unabated coal usage. With the current energy consumption expectation as well as both emission targets and countries' pledges in mind, the global community can curtail the temperature rise drastically and limit the rise to +2.0 °C. Going into COP27, there was an overwhelming demand to limit the global temperature rise to +1.5 °C to avoid the worst effects of climate change, yet the current overall increase is +1.2 °C.[2] Based on current policies and behavior, climate models predict that Earth's global average temperature will rise +2.7 °C by

Received: December 1, 2022
Accepted: December 13, 2022
Published: January 30, 2023

Figure 1. The ACS student delegation photo collage from COP27 in Sharm El-Sheikh, Egypt. The top left photo features the entire ACS student delegation and the two faculty advisors from left to right: Jaime Ayala, Tiffany Sill, Cailey Carpenter, Shelby Dye, Julianne Rolf, Gregory Foy, Keith Peterman, Anna Lisa, Brady Hill, Emma Kocik, Spencer Smith, and Jordon Horton. The bottom left image is the week one team from left to right: Jaime Ayala, Julianne Rolf, Tiffany Sill, Shelby Dye, and Cailey Carpenter. The bottom center from left to right is Cailey Carpenter, Shelby Dye, and Julianne Rolf. The top and bottom right photos depict Tiffany Sill and Jaime Ayala at COP27. The middle right image is the week two team from left to right: Jordon Horton, Anna Lisa, Spencer Smith, Emma Kocik, and Brady Hill.

2100. However, the best-case scenario says anthropogenic sources will push the world to overshoot the desired goal by at least +0.3 °C.[2] With the global population exceeding 8 billion people, many countries have begun to industrialize more rapidly to suit the needs of their growing citizenry. While rapid industrialization is beneficial, it does impact our chances of achieving our desired climate goal. Without more swift action by humanity, Earth is in for a cascading climate catastrophe with the potential to change the face of the planet for generations to come.

REQUIRED ACTION

At this point in time, a reduction in GHG emissions and decarbonization alone will not be enough to significantly impact anthropogenic influences on the climate change crisis.[3−5] Emerging mitigation and adaptation strategies include, but are not limited to, overall energy expenditure reduction, carbon sequestration, an energy paradigm shift toward clean energy sources, and the clean development mechanism. The feasibility of these approaches hinges on a substantial amount of technological development and capital investment in current and emergent technologies.[3] Global climate finance flows are currently around $650 billion per year, but in order to achieve the 2030 goals from the Paris Agreement (50% decrease in GHG emissions), annual flows will need to reach $4.5−5 trillion.[6,7] Consequently, it is important to evaluate the likelihood and magnitude of each individual tactic and assess its potential impact on a sector-by-sector basis.[4,5] Analytical tools for detailed climate prediction models including life cycle analysis,[8,9] emissions trackers,[10−12] and soil and water assessments[13,14] are currently being utilized in an enormous amount of peer-reviewed literature. It is noteworthy to mention that the impact of mitigation strategies can be significant but are not all positive. We will briefly discuss the impact of mitigation in the context of hard-to-abate sectors as they account for the lion's share of global GHGs and energy expenditure. The remainder of this article will focus on COP27 student observers' perspective that climate policy and mitigation efforts are largely contingent on climate literacy and public acceptance.

Hard-to-abate sectors include segments of the global economy such as energy-intensive industries (EIIs), heavy transportation, agriculture, and the built environment. Therefore, the transition to net-zero is not straightforward due to cost prohibitive, undeveloped, or underdeveloped technologies. Urban centers have a significant impact on climate change as the built environment accounts for a third of global GHG emissions and 30−40% of the overall global energy expenditure.[1,9,15] The world's population nearly doubled from 1970 to 2015, triggering rapid urbanization across the globe.[15] As a result, the selection of building materials, most of which are manufactured through energy-intensive industrial processes, has become increasingly important. EIIs, such as the production of steel, cement, aluminum, petrochemicals, and fertilizers, are a vital part of industrialized society and responsible for 22% of global CO_2 emissions.[16] However, their net-zero production pathways are costly, which will initiate a drastic rise in prices of those materials. If steel is produced from renewable hydrogen sources, some accounts suggest that the price will rise between 20−40%.[17] Carbon capture and storage sources for cement production can possibly result in a 70−100% increase in cost.[18] Replacing

https://doi.org/10.1021/acsomega.2c07674
ACS Omega 2023, 8, 4430−4435

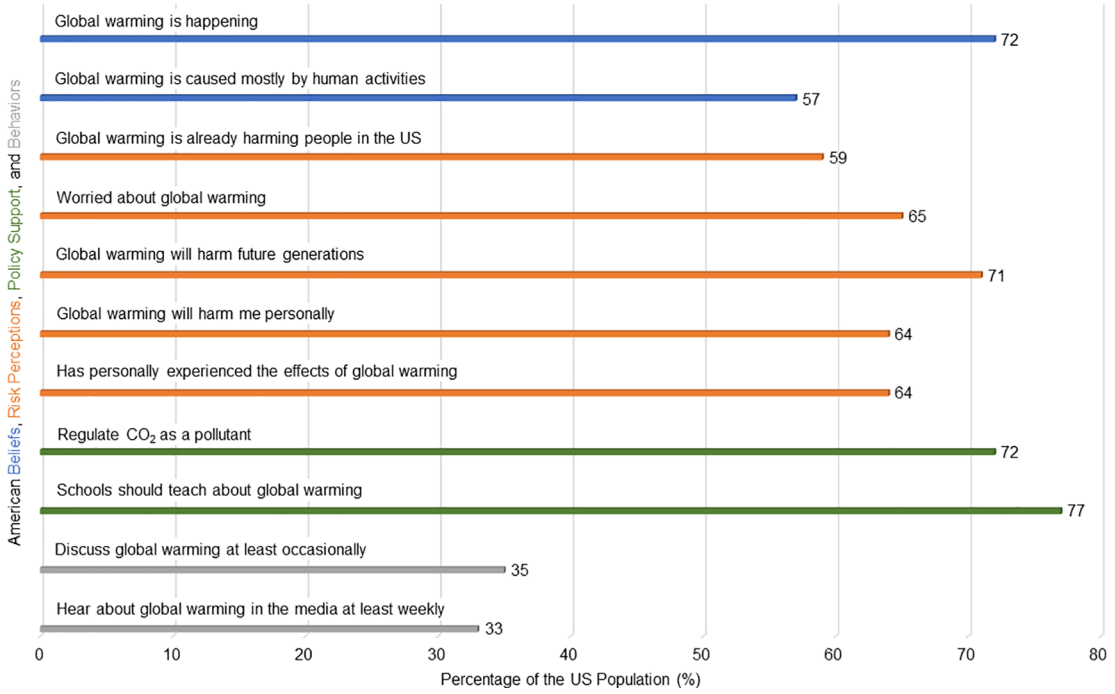


Figure 2. A graph correlating US public opinion with a variety of climate change perceptions. Color coded bars denote a category of American viewpoints. The adjacent number expresses the percentage of the US population that holds these viewpoints. The blue bars indicate beliefs, orange bars represent risk perceptions, green bars signify policy support, and gray bars purport behaviors.

fossil fuel feedstock with renewable electricity and hydrogen sources are expected to substantially increase plastic prices.[19] While increased manufacturing costs adds only a minor amount (~1−2%) to the selling price, implementation of these strategies will need to be carefully evaluated as developing countries will be disproportionately affected as they industrialize and urbanize.[4,5,15,16] Some current approaches to increase the energy-efficiency and reduce the carbon footprint of hard-to-abate sectors include incorporation of ferrovanadium micro-alloys in construction and transportation,[9,20−22] utilization of fenestration elements to reduce energy requirements of the built environment,[23−26] and reduction of embodied energy of buildings through judicious choice of construction materials.[27,28] Integration of a multitude of mitigation and adaptation strategies are required to facilitate a sufficient impact on GHG emissions and energy consumption in hard-to-abate sectors. It is important to note that while there may currently be an increased cost associated with low and zero carbon products, such goods and services will become exponentially cheaper as the technologies continue to develop. This was the case with batteries as well as renewable energy equipment like wind turbines and photovoltaic panels.[29−31] In addition, the cost of energy generation is decreasing. For instance, some renewable energy sources, such as onshore wind and solar, already cost less than fossil fuel derived energy forms.[32]

CLIMATE LITERACY AND ITS CHALLENGES

According to the 2021 Yale Climate Opinions Maps, approximately 72% of Americans believe that climate change is occurring (Figure 2). However, perceptions of climate change vary significantly at the county-level. For instance, elected representatives from urban geographic regions commonly support climate-related policy such as climate literacy programs throughout school systems. Whereas their rural-based counterparts generally oppose climate-based legislation.[33] Enactment of mitigation efforts has proven to be challenging. Political controversy over the subject matter has painted elected representatives into a corner while they account for constituency priorities when drafting and voting on legislation. The disparity arises from the fact that only 57% of the population, depicted in Figure 2, accepts that climate change has escalated as a result of anthropogenic causes.[33] Emerging evidence suggests individuals' interpretations of climate change are largely influenced by perceptions of changes in their own local weather patterns,[34] pluralistic ignorance,[35] and the human associative and affective processes that lead to emotional rather than analytical responses to uncertainty.[36] Ergo, it has become critical to rapidly advance climate literacy and the dissemination of data-driven interpretations throughout the global community to curtail misconceptions resulting from a lack of understanding.

In the imperative to strive for a climate-literate citizenry, climate science has increasingly become more accessible *via* a multitude of emergent educational resources including popular science articles, workshops, websites, television specials, and school systems. Yet very few of these outlets are citing peer-reviewed scientific literature. The lack of cited data use by these resources has led to a separation between scientific fact and the dissemination of information, which has fueled misconceptions among the populace. Additionally, due to the large political divide, some school boards encourage teachers to incorporate climate science in the curriculum while other regions advocate for the opposite. One study found that high school students report the inclusion of climate science topics in coursework at the following rates: Biology - 46%, Chemistry - 17%, Physics - 8%, and other courses - 25%. Nevertheless, only 32% of students agreed that climate change is caused by anthropogenic activity.[37] These findings underpin the indication that the current sources of information are

https://doi.org/10.1021/acsomega.2c07674
ACS Omega 2023, 8, 4430−4435

propagating the fundamental misunderstanding regarding climate science. Many common misconceptions can be addressed through cited information sharing by enacting policy to establish data-driven climate literacy programs throughout all school systems.

In COP context, this translates to 197 countries, territories, and indigenous peoples who sent delegations to show their commitment to addressing climate change. However, out of the participant population, almost none require national climate literacy for kindergarten through high school students. Italy was the first country to have compulsory climate education starting in September 2020, and Israel recently followed suit.[38−40] In 2021, the UN Educational, Scientific and Cultural Organization's International Bureau of Education launched an open-access book, *Curriculum and Learning for Climate Action*, to assist nations' endeavors in the introduction of climate literacy curriculum within school systems.[41] With model nations and readily available curriculum resources, the major challenge is influencing the remaining nations to commit to compulsory climate literacy through climate policy.

PUBLIC OPINION SHAPING CLIMATE POLICY

In democratic systems, public acceptance is required for the development and implementation of climate-based legislation. Swaying popular opinion starts on the individual level as socioeconomic variables such as degree of education, community engagement, and political affiliation will heavily influence personal viewpoints.[42] Despite climate-related scientific data, public opinion has continued to drastically oscillate over the past 50 years. The aftermath of devastating weather events elevates the public outcry for climate change legislation to its peak, while the same public's opinion dwindles down to a minimum as climate fatigue fuels the social attenuation of risk.[43] The establishment and implementation of climate-driven policies require public support yielding a critical imperative to effectively communicate scientifically credible information in a broadly accessible format.[44]

One strategy to help realize this goal has been utilized by the ACS *via* the annual appointment of a student delegation who attends the COP conferences. ACS-delegated student representatives each select a topic of research that is presented by renowned climate scientists at COP. Student ambassadors then attend topic-relevant sessions hosted by different countries and academic or scientific organizations. Subsequently, the student attendees report their findings through established blogs, social media posts, and oral presentations at the Climate Literacy Symposium during the ACS Spring National Meeting. Climate literacy and emergent strategies for the dissemination of data-driven climate information remained a hot-topic at the most recent COP conference in Egypt. During COP27, Professor Sun-Jin Yun from Seoul National University presented the argument that the key to achieving a climate-literate citizenry lies with shifting the perspective from collective action to personal action. She highlighted the need for each person to take ownership of their part in the global climate change mitigation effort. Furthermore, Professor Yun emphasized that individual efforts could tip the scale toward the pragmatic moderation of anthropogenic contributions to global climate change.[45]

CONCLUSIONS AND FUTURE OUTLOOK

Global decarbonization cannot single-handedly mitigate human influences on climate change, but it is an important start. Decarbonization requires collective efforts spanning across the world, especially from the highest contributors to global GHG emissions and energy consumption. During COP27, the US demonstrated leadership by demanding others to implement laws similar to the Inflation Reduction Act, which is the most significant climate-based legislation in the US to date. Interestingly, the US has one of the highest proportions of climate change deniers who impede climate-driven policies. Current momentum for innovation and collaboration is driving mitigation and adaptation efforts to the level necessary to reach the +1.8 °C best-case scenario. Public support is essential to push governments to implement additional mitigation measures. Dissemination of misinformation presents a major challenge in shifting the public opinion as perceptions about climate change are exceptionally complex in nature. The best approach to gain public support is to create a climate literate citizenry through establishing credible educational resources and climate science curriculum within school systems. A climate literate population will lead to a ripple effect initiated by people taking ownership of their individual contributions, propagating national mitigation practices, expanding adaptation policies, and instigating global action. As student delegates at COP27, we were able to catalyze credible information sharing as we became the connection between the scientific community and our own social network. We were able to talk to experts in our respective fields about their research and gain valuable insights on how to proceed with our own research. Students attending COP27 are the future of those events, and we will be watching our predecessors closely for how to continue the work to protect our planet.

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https://doi.org/10.1021/acsomega.2c07674
ACS Omega 2023, 8, 4430−4435

Notes

The authors declare no competing financial interest.

■ ACKNOWLEDGMENTS

T.E.S. acknowledges the support of the NSF under a Graduate Research Fellowship grant DGE: 1746932. J.R. acknowledges support from the NSF Nanosystems Engineering Research Center for Nanotechnology-Enabled Water Treatment (EEC-1449500), Yale School of Engineering and Applied Science, Yale Department of Chemical and Environmental Engineering, Tau Beta Pi Fellowship, and P.E.O. Scholar Award as the Yao Ming Charitable Fund Named Scholar

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