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Climate Change Impacts and Engineering Solutions

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Abstract

With climate change entering the forefront of global issues, the need for sustainable practices that can provide for human welfare, social and economic development, and health has become more urgent than ever. Despite the recent increase in climate change impacts around the world, many people are still unaware of the severity of the situation. Changing public perception of these issues is the first step in enacting change and increasing accessibility to this information plays an important role.

Much of the information people consume today comes in the form of video, and it can be an effective tool to change knowledge and behaviors. The findings from this research have been displayed in video form to make the reality of climate change more accessible and visually impactful. Engineering plays a large role in the mitigation of climate change, and these efforts are highlighted in the video through the examples of reduced methane production in rice fields and water resources management in Salt Lake City, UT. Two interviews were conducted (one on each topic) to form the narrative of the video. These two topics were chosen to provide distinct examples of how engineers are mitigating climate change impacts locally and across the country.

The video was posted to YouTube to track viewer engagement and overall public opinion. It is currently being promoted through sources such as the University of Arkansas Department of Biological Engineering, University of Arkansas Honors College, and University of Arkansas System Division of Agriculture to increase visibility. As our population continues to grow rapidly in the coming years, the need for solutions to the issues featured in this video will become increasingly urgent. Education about these issues is crucial to making positive change in our society.

Introduction

Earth's climate has been rapidly warming over the past 150 years, increasing by more than 0.85 degrees Celsius (1.5 degrees Fahrenheit) since 1880 (Licker, 2022). Recent warming has been attributed to the drastic increase in atmospheric greenhouse gas (GHG) concentrations beginning around 150 years ago. Current GHG concentrations are at record-high levels compared to the past 800,000 years, and the primary sources are emissions from fossil fuels, deforestation, and agricultural activities (Meinshausen et al., 2017). This warming has led to a large decrease in available fresh water for many arid environments across the globe, and these impacts are only expected to intensify. Some engineers are working to mitigate these impacts, but their efforts are not often highlighted. Educating the public on the urgency of climate change and mitigation strategies is crucial to reducing related impacts.

The increase in population and standard of living in many parts of the world has led to an increased consumption of food, water, and energy. The dominance of fossil-fuel based power generation combined with an exponential increase in population in recent decades has resulted in a positive feedback loop between population and GHG emissions (Owusu and Asumadu-Sarkodie, 2016). Food production has also increased to meet rising population levels, which produces GHG emissions such as methane (CH_4) from rice fields and beef production (Neue, 1993). Increased warming associated with these gases is also expected to continue to reduce available freshwater resources and increase water demand throughout the U.S. (Hall et al., 2008).

Food, water, and energy demand are unlikely to slow in coming decades based on current population trends (De Amorim et al., 2018). Engineering efforts to limit and mitigate climate change stretch from genetic engineering of coral reefs to local green roofs. Many of these projects lack substantial visibility, but these efforts should be showcased to better inform the

public of these pressing issues. The goal of this research is to increase awareness of climate change impacts and ultimately change human behaviors using a video. YouTube videos in particular can be effective learning tools (Moghavvemi et al., 2018). The specific objectives of this video are to explain what climate change is, give examples of some of the effects seen today, highlight engineering projects that address these issues, and inspire people to make a difference in their own lives.

Video Outline

In order to make these climate change related impacts and engineering solutions more accessible, a five to seven minute video was constructed to highlight some related projects. Modern technology and social media have allowed video to become one of the most effective communication and education tools today (Brame, 2015). COVID-19 has forced many people to adapt to online communication, making video an even more effective tool now than ever. This influence will be used to highlight some important issues related to climate change, along with the perspectives of the people who are directly involved.

The video opens with a broad overview of climate change. This intro includes what climate change is, sources of GHG emissions, and broader related impacts. The sources for GHG emissions are shown using several shots of common sources including fossil fuel combustion (automobiles, coal power plants) and agriculture (soybean, rice, etc.). This b-roll was shot locally for the most part, with some shots coming from the rice research fields in Stuttgart, AR.

The next section of the video introduces the idea that engineering is being used to help mitigate and solve some of these climate change related issues. This transitions into a more in-depth example section which begins with a local example. Many people associate GHGs with cars and factories but do not realize that around one-fourth of total anthropogenic GHG

emissions come from agriculture (Bennetzen et al., 2016). Arkansas contains over 50% of the land for rice production in the United States, and global rice production contributes around 11% of anthropogenic methane emissions (Ciais et al., 2013). To help visualize the relative impact of methane versus carbon dioxide, a graphic was constructed using Adobe After Effects.

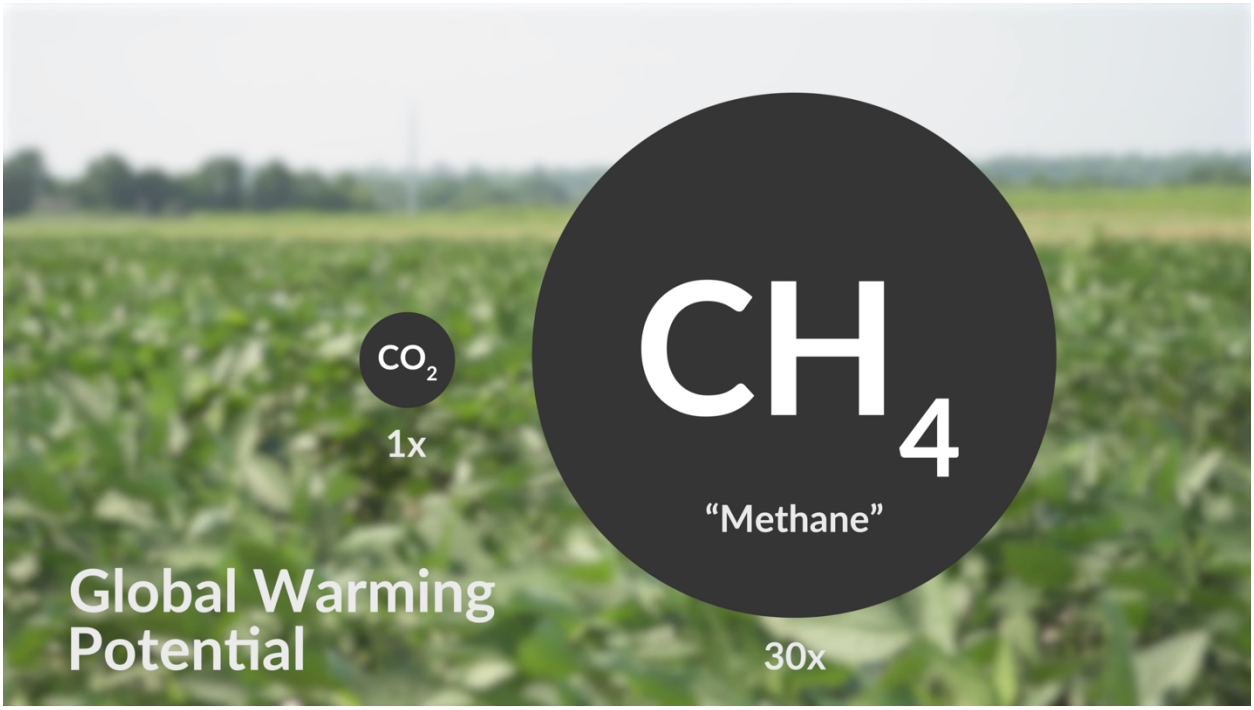

Figure 1: Graphic from final video illustrating the relative global warming potential difference between CO_2 and Methane

By creating graphics that simplify the data, these concepts are made clearer.

The alternate wetting and drying (AWD) irrigation practice was shown to help mitigate this problem while also conserving water (Runkle et al., 2019). This strategy not only reduces GHG emissions, but also serves as an economic benefit to rice producers. An interview with Dr. Runkle, a professor at the University of Arkansas, was conducted explaining his research in the video. This video serves as the narrative for the section, and b-roll to help support this narrative was shot across central and northwest Arkansas.

Figure 2: Eddy covariance system in Stuttgart, AR rice research field used to measure GHG concentrations

Irregular weather patterns become increasingly concerning in many areas of the world due to climate change, and the next section of the video focuses on these impacts in the western U.S. The Great Salt Lake in northwestern Utah is the largest saltwater lake in the Western Hemisphere, but recent pressures from climate change and population growth have caused a drastic decline in water levels over the past few decades (Baxter and Butler, 2020). With decreased precipitation and shifts in normal temperature patterns, the timing of snowmelt has been altered as well. This snowmelt is the primary source of water for the lake, but increasing pressures for water usage upstream to support the booming population around Salt Lake City threaten this balance (Baxter and Butler, 2020). Utah has one of the highest per capita public water usage levels of any state, making their lack of available fresh water an even greater concern. A graphic was created to help illustrate this issue and engage viewers.

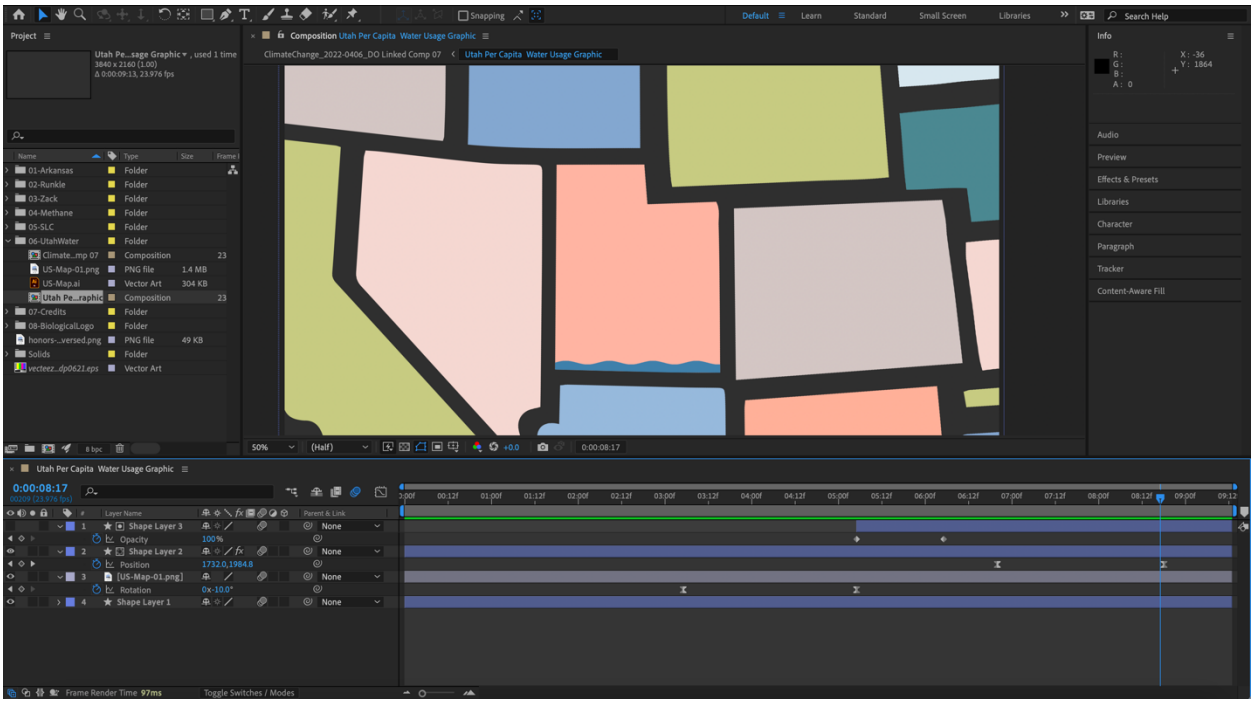

Figure 3: Utah water usage graphic showing a decline in available surface water, being created in Adobe After Effects

As water levels in the lake continue to decline, issues related to the air quality, the lake's ecosystem, and the estimated $1.5 billion economic value of the lake are at stake (Null and Wurtsbaugh, 2020). To help portray the urgency of this situation, former University of Arkansas Biological Engineering graduate Zack Wofford was interviewed. At his current position working for the Weber Basin Water Conservancy District, Zack is responsible for addressing these issues related to water resources. A tour of some of their facilities and project sites was given, and footage was collected to relay this information in the video.

Figure 4: Aerial shot from the Great Salt Lake showing record low water levels

After the initial video draft was created, it was sent to Dr. Runkle and Zack Wofford for review. Revisions are an important step in any project, so incorporating feedback from the subjects of the video was made a priority. Because so much information was cut out and condensed from the full interviews that were shot, it was important to ensure that the subjects thought their information was accurately portrayed in the final video. Their feedback was mainly positive, and the only necessary changes that were made dealt with credits at the end of the video.

With online media being the main information source for most people, it is important for the Biological Engineering department to engage potential students through this platform. With traditional recruiting methods being partially stunted due to COVID-19 impacts and a decrease in enrollment, online media can be a great alternative to showcase the degree program (Day et al., 2021). Several references to the Biological Engineering department were included in the final video, including the opening shot of the department logo, Dr. Runkle's title, and even the student

club shirt Zack was wearing. This branding helps increase interest in the degree program and gives prospective students an idea of some of the potential career paths they can take with a Biological Engineering degree.

Up-to-date equipment such as cameras, microphones, and lighting were used to make the video look as professional as possible. Aerial footage was captured using a drone, and Federal Aviation Administration guidelines were followed. A shot list was constructed at the beginning of the project to help guide some of the shot choices made when filming on location (see appendix). Since the focus of this project is to increase awareness about climate change related problems and solutions, maintaining audience engagement is crucial. In order to present the most information without sacrificing effectiveness, the full-length version was kept under 7 minutes since condensed content has been found to result in increased viewer engagement (Brame, 2015). The final video was posted to YouTube under the shortened title "Sustainable Engineering: Climate Change" to maintain simplicity for viewers. Tags such as "UARK Biological Engineering", "UARK Honors College", and "Climate Change" were also used to increase visibility on the platform.

The editing process for the video involved several software. Adobe Premiere Pro was the main editing software that was used for cutting clips, adding music, color correcting, and building the overall sequence. All footage used in the final video was self-shot and edited. Foley and music were added using a licensed music software website that a free subscription was obtained for (www.epidemicsound.com). Foley was strategically selected for certain scenes to draw viewers in, such as the addition of a waterfall sound effect during the aerial shot of the reservoir discharge stream. All footage was also shot in a flat picture profile to preserve highlights and shadows. This required color correction for every shot but resulted in a much

more dynamic shot composition in the end. Adobe After Effects was used to create all graphics and titles, including the title screens, credits, logo screens, and lower-thirds titles for both video subjects. These After Effects compositions were incorporated into the sequence in Premiere Pro. Adobe Audition was also necessary in certain cases when audio required cleaning. For example, a distracting chair squeak sound was present in one of Dr. Runkle's interview clips, so Audition was used to remove the sound. Finally, Adobe Illustrator was used to create the final thumbnail visible on YouTube.

After posting to YouTube, the video had a great response. The video received over 170 views in the first week with many viewers coming from promotion via Twitter. Dr. Jennie Popp from the University of Arkansas Honors College also reached out to communicate her intent to share the video with her environmental economics class. An interview with A+ Magazine was also conducted regarding the video, which will lead to further promotion in the coming months. The video was meant to resonate with people and motivate change, and by making information on climate change impacts and engineering mitigation strategies accessible and interesting, new audiences are being reached.

Final Video: https://youtu.be/jAq4i7TfAnE

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Appendix

Climate Change and Engineering Shot List

Shot #	Description	Notes
1	Drone shot of factory/industrial park, smoke, etc. (south Memphis?)	Wind foley
2	More b-roll of factory, pollution	Audio of Dr. Runkle talking comes in about GHG emissions
3	Interview clip of Dr. Runkle, end of GHG statement	Shoot 4K for cutting to close-up
4	Possible car driving up from distance early morning, rice fields, dirt road	Music fades back in
5	Drone shot following car in distance, showing scenery	Runkle Audio comes back
6	Runkle interview, lower thirds title, explaining research	
7	B-roll of rice, equipment, researchers in field, etc.	
8	Drone shot showing scale of rice fields	
9	… Transition shot with new introductory title screen	Fade between music tracks, blend
10	Shots of irrigation? Possible streams nearby, something to illustrate water conservation	Segway with water scarcity talk
11	Transition options: Drone shot above stream fade to stream in West; timelapse sunset fade to black, fade in sunrise west (maybe over salt lake, birds?)	Focus on getting clean audio of birds with mic if possible
12	Interview clip of Zack, introducing the focus of his work	

Appendix showing a rough shot list used for pre-production in the video creation process.