ACS Climate Change Advocacy Workshop

Audio Transcript: (2) Module 2: Climate change and society

2.1 Societal and environmental impacts

2.1.1 The ripple effect

The impact of human activities reaches well beyond simply producing more emissions. As humans add more carbon dioxide and methane to the air, more heat becomes trapped due to the greenhouse effect. Ocean and air temperatures increase, and Earth's climate patterns slowly start to change. Warmer weather carries more energy which causes stronger storms, and leads to more extreme droughts, among other things. Climate change impacts the environment and people – and some people more than others.

Climate change is a risk multiplier – it exacerbates issues that already exist. Communities of color, as well as low-income and immigrant communities, are disproportionately impacted by climate change. This ripple effect demonstrates how intrinsically connected human activities are with climate change and how climate change is impacting or will further impact lives.

2.1.2 Climate justice

According to the Intergovernmental Panel on Climate Change – or IPCC -- climate justice encompasses three components. The first is distributive justice, which means spreading out the burdens and benefits between different people, areas of the world, and all ages. The second is procedural justice, which describes who can contribute to decision-making and who makes decisions. Third is recognition, which means ensuring diverse cultures and perspectives are respected, fairly considered, and continuously engaged. This is a broad term that can be used differently by different communities, but includes a human rights-based approach to addressing climate change.

2.1.3 Climate change impacts on society

Focusing on climate and weather patterns specifically, below are some examples of how societies can be negatively impacted by climate change. The extra energy added to climate systems slightly shifts regional climates and weather patterns to be more extreme, leading to more intense storms which can bring too much water and disrupt essential services. Intense heat can increase air conditioning and energy costs, and increase both exhaustion and deaths related to warmer temperatures. Lack of rainfall or extreme drought can make conditions drier and more prone to uncontrollable wildfires. Without rainfall to replenish, drinking water sources can be depleted. All of these hazards disproportionately impact Black, Indigenous, Latinx, immigrant, and low-income communities the most.

2.1.4 Transition

In the next section, you will explore societal impacts of climate change in more detail.

2.2 Impacts on the environment

In the activity below, click the different hotspots – that show up as purple circles – to learn more about how climate change is transforming our living environment. These changes are happening now and are expected to increase over the next few decades.

2.3 Impacts on agriculture

This activity is similar to the one before it, except it drills down into a specific sector - agriculture. Click on the various hotspots – that show up as blue circles – to learn how climate change is impacting the agricultural sector.

2.4 Impacts on society

2.4.1 Impacts to society

Continued and significant changes to the environment have had and will continue to have tangible, negative consequences and impacts for societies. Some of the overarching areas of concern that will see impacts are: shelter, cultural identity, economic well-being, air quality, food and water security, and health. The next few slides will provide more details for each overarching area from a U.S. perspective. Note, this is not meant to be a comprehensive list of all impacts.

2.4.2 Shelter

More severe and frequent storms and wildfires, rising sea levels, and other climate-related events mean an increased risk for people's homes, businesses, and valuable assets. Some risks include: destruction of homes from natural disasters, increased cost of insurance, complete loss of homes and land to sea level rise, and increased stress on aging and fragile infrastructure such as dams, roads, bridges, and electrical grids.

2.4.3 Cultural identity

Communities throughout the United States identify closely with their surroundings, environments, and depend economically on them. The impacts from climate change therefore threaten not only subsistence but also cultural identities for many communities. Some ways cultural identity is being threatened are: loss of cultural and national heritage sites due to a changing environment and increased storms; depletion of food sources that bind communities and cultures together; relocation of entire communities due to sea level rise that remove communities from ancestral lands and ancestors; loss of plants, animal species, foods, water, and lands that can be at the center of communal identities.

2.4.4 Economic well-being

The impacts of climate change on the environment and societies are and will continue to be endured from an economic standpoint. Some economic risks are: loss of crops due to warming temperatures and severe storms. Increased cost of water, food, and energy due to severe storms, droughts, and more. Increased cost of insurance to protect assets from disasters. Destruction and disruption of daily life due to increased natural disasters. Increased inequality as vulnerable communities struggle to adapt or uproot in the face of disasters. And Indigenous communities who have historically been displaced into lands that leave communities economically vulnerable. This vulnerability is likely to worsen with changes resulting from climate change.

2.4.5 Air quality

In the United States alone, millions of individuals have communities where air pollution exceeds air quality standards. Worse yet, unfettered GHG emissions will worsen existing air pollution levels and continue to impact people's health. Additionally, with wildfires expected to become more frequent and severe, it is also expected that more people will see diminished air quality and increased risk to their health.

2.4.6 Food and water security

As noted, more severe and frequent weather events are expected. All of which have impacts on food and water security. Below are just some predictions in this area: Increase in food and waterborne illnesses. Specifically, there is an expectation of increased pests and weeds which may require more pesticides and thus an increased risk of toxic conditions for people. Additionally, pathogens such as *Salmonella* are expected to thrive and threaten human health.

Crops and marine life will likely see an increase in harm as well. Droughts, wildfires, or severe precipitation will impact crop yields. Warming temperatures will impact the health of marine ecosystems. Ultimately, unpredictability in weather patterns and increased storms – among other things – will impact the ability to produce food and collect water. This has the potential to drive costs up and increase food inequality and insecurity.

2.4.7 Health impacts

As mentioned in the air quality section, current and continued pollution from GHGs has a negative impact on human health. Additional environmental and climate changes do as well. Below are some examples of what societies can expect: First, lung health concerns, cardiovascular diseases, premature death, aggravated asthma, and shortness of breath from the presence of pollutants such as: nitrous oxide, hydrofluorocarbons, ground-level ozone from burning fossil fuels, particles in the air sized at 2.5 parts per million that originate from things such as power plants, wildfires, and more. Second, increased risk to heat strokes, heart attacks, preterm births, and more due to heat stress. Third, increased impacts to mental health and stress-related disorders. And fourth, greater exposure to vector-borne diseases as a result of changing weather patterns. Additionally, warmer temperatures can interfere with certain medicines taken.

2.4.8 Health impacts to vulnerable communities

Unfortunately, the impacts of climate change are not and will not be distributed equally. Communities of color, low-income communities, Indigenous Nations, older adults, and children live, work, and play in areas most likely to see pollution-related diseases, extreme temperatures, extreme rainfall, and weather events.

It is therefore important to ensure local input into climate change policy, mitigation, and adaptation efforts include all peoples. While the negative consequences to society seem dire, it is important not to lose hope. Solutions are possible! In the next few slides, you will learn about some specific examples and be presented with solutions.

2.4.9 Example: Air pollution and health inequities

In a recent study by Castillo et al., 2021 published in GeoHealth, scientists showed that populations with higher exposure to fine particulate pollution and poor air quality had higher risks of health problems. The image on the right by the NASA Earth Observatory shows a map of Washington, D.C. color coded by mortality related to particulate matter sized at 2.5 parts per million – which is depicted from light pink to dark pink – and the percentage of Black residents – depicted with light green to dark green – both on a low to high percentage scale. Ground-based monitors suggested that particulate matter sized at 2.5 parts per million was higher in areas with lower incomes and higher proportions of Black, Latino, and people of color more generally.

While the information shown is stark, it's also important to remember that data and knowledge provide opportunities to continue improving air quality and for policymakers to directly see, acknowledge, and address inequities. Furthermore, it's important to examine where schools, community centers, and polluting industries are built to minimize exposure to the most vulnerable communities. The next slide outlines some potential solutions to air pollution.

2.4.10 Potential solutions to air pollution

Air pollution is a problem that can be solved. Below are some examples of potential solutions. Advocating for stricter emissions standards from factories and industrial facilities to reduce emissions at the source. Choosing public transportation or ridesharing if available, reducing trips taken, and avoiding gas-powered lawn equipment. Equitably distributing future manufacturing and energy producing sites to ensure that no one community is impacted more than another. Directing funds and resources directly to the communities to implement changes needed. There also needs to be a larger community-wide and political effort to address impacts from underlying issues such as redlining, which takes a lot more effort and power to undo or reverse but is feasible.

2.4.11 Urban heat islands

Another example of impacts to societies is the concept of urban heat islands, which are areas with more buildings, roads, concrete, and asphalt that absorb and reflect the sun's heat and are warmer compared to parks and other green areas. As global temperatures increase due to climate change, the harmful effects of urban heat islands will intensify, impacting the humans who live in cities. The harmful effects include heat-related deaths and illnesses such as cramps, exhaustion, and heat stroke. Heat equity refers to the idea of implementing policies to help those who are most vulnerable to heat island effects, including adults 65 and older – and people with pre-existing medical conditions, and reduces the inequitable distribution of risks across urban areas. Relationships between race, income level, and hotter neighborhoods have been identified as well.

The image on the right by NOAA shows Washington, D.C.'s urban heat island areas. Red indicates a hotter measured temperature and blue indicates a lower measured temperature. Notably, Rock Creek Park is dark blue in color whereas downtown D.C. and other urban areas are brighter red.

2.4.12 Solutions to urban heat islands

Like air pollution, urban heat islands can be solved. Mitigating the harmful effects of urban heat islands include actions such as planting more trees and creating more green spaces. Increasing the albedo – or in other words the reflectivity – of surfaces and buildings by replacing dark asphalt with lighter colors to reflect heat helps as well. Investing in energy-efficient buildings or updates to keep air conditioning and appliance use low is also a great mitigation strategy.

2.4.13 Transition

In the next section, you will learn more about strategies for climate change mitigation and adaptation.

2.5 Climate change mitigation and adaptation strategies

2.5.1 Mitigation and adaptation definitions

Now that you have learned about the impacts of climate change – both on the environment and society, take a look at some of the efforts being made to mitigate and adapt to these impacts. Below are two important definitions: *Mitigation* includes efforts that reduce the emission of greenhouse gases from the start, and actions that directly reduce contributors to climate change. *Adaptation* refers to efforts that contribute to resiliency in the face of climate change, and actions that lessen the impacts of climate change felt by communities.

2.5.2 Mitigation strategies

Strategies for mitigation include reducing dependence on fossil fuels to burn for energy, adopting renewable energy sources – such as solar, wind, hydropower – and preserving green space. Additionally, using green building techniques and reusing existing infrastructure when possible as well as walking, biking, or taking public transportation options to reduce fossil fuel usage in transportation can also mitigate emissions of greenhouse gases.

2.5.3 Global mitigation strategies

There are also ways that countries can work to lower emissions on the international scale. Countries can commit to lowering their greenhouse gas emissions, investing in renewable energy sources, and implementing laws and agreements between countries for lowering emissions. They can also provide support to countries that are not readily able to make these costly transitions.

2.5.4 Example: Methane mitigation

Humans cause about 60 percent of methane emissions. To mitigate methane emissions, a point-source fix is to repair pipeline methane leaks or to convert methane chemically to CO_2 or a less harmful substance. The C&EN article image shown here illustrates different areas where methane, specifically, is emitted and examples of each. Fossil fuels are 35.8 percent of human emissions, cattle 30.5 percent, landfills and waste 18 percent, rice farming 8 percent, and biomass and biofuel burning 7.7 percent. Together, they are all examples of human-caused methane emissions and in 2017 made up 364 million metric tons of human-made methane emissions.

2.5.5 Adaptation strategies

Societies also have ample mechanisms to increase their strategies for adaptation. Below, a few examples are listed, and include: Better use of scarce water resources. Rethinking building zoning. Adding green roofs and rain gardens. Increasing albedo – or reflectivity – of buildings & infrastructure for enhanced light and heat reflection. Upgrading stormwater systems to handle more water. And lastly, coordinating climate change projections into decisionmaking.

2.5.6 Adaptation tool

Check out your city's ParkScore to see how access, investment, acreage, amenities, and equity factor into its park system. Click the resource icon on the bottom right.

2.5.7 Resiliency definition

Another important term is resiliency. Resiliency is similar to adaptation and mitigation, but it's a measure of a community, city, state, or country's ability to recover from a storm, flooding, wildfire, or similar severe climate change-induced events or disasters. It refers to the infrastructure's capacity to handle excess water or debris, withstand high winds and temperatures, and more. The next few slides go into more detail.

2.5.8 Resilience strategies

Strategies for resilience are closely connected with mitigation and adaptation strategies and are often interwoven. The resiliency of a community starts with learning and understanding the potential hazards and assessing the risks to the community and its vulnerability. Once these are known, looking into options for upgrading and modifying existing infrastructure, planning, and priorities will help to foster resiliency. Finally, monitoring, reviewing, communicating, and continually adjusting is key to improving the overall resiliency of a community. For successful efforts to combat climate change, a society needs policy and action plans within these three realms.

2.5.9a A note about hope

It's important to note that climate change is not a hopeless issue, despite it sometimes feeling that way. There are many ways to take action on an individual level, and many cities, states, and local communities are taking on some great projects and plans to mitigate, adapt, and/or become more resilient to climate change. Click on the resource icon below to explore a collection of examples of various groups around the country and their projects. Look to see if there are organizations within your own community working to combat climate change impacts, especially if you wish to reach out and get involved.

2.5.10 Transition

In the next section, you will explore different technologies and strategies to combat climate change.

2.6 Climate change mitigation and adaptation technologies

2.6.1 Energy transition

Atmospheric carbon dioxide concentrations are increasing at a rate never observed before, primarily due to emissions from fossil fuel combustion. A critical and essential part of mitigating climate change is reducing the Unites States' and the world's dependence on fossil fuels like coal, petroleum, and natural gas. Refining and burning these fuels releases immense quantities of emissions that contribute directly to climate change.

Switching to renewable energy sources like solar, wind, geothermal, and others are key.

2.6.2 Energy sources

Transitioning away from vehicles and transportation options powered by fossil fuels is one important step in the process. Mitigation policies such as increasing the use of renewable clean energy technologies are key.

Looking at the big picture, it’s important to transition power plants away from burning and using fossil fuels as well. The source of energy in homes and businesses must also come from renewable clean energy sources in order to reduce human-made emissions.

2.6.3 Carbon sequestration

A common term used in mitigation and adaptation planning as a potential technology and policy solution is carbon sequestration. Click the blue ‘turn’ icon to read the definition of this important term.

2.6.4 Carbon sequestration benefits

The benefits of carbon sequestration are that it directly addresses the key cause of the climate crisis, and aids in resiliency efforts. It also not only removes current and potentially any future emissions, but also helps to address historic emissions as well. Finally, it can help to balance out emissions from economic areas that are not easy to decarbonize. While it is not something to rely on long-term, it can provide some flexibility during the time it takes to decarbonize those sectors.

2.6.5 Carbon sequestration technology

The U.S. Department of Energy is focusing on many different areas to manage carbon. The first is point source carbon capture, which would not allow carbon emissions to escape to the atmosphere. Second is the transport and storage of carbon dioxide emissions deep underground, and third is CO_2 removal from the atmosphere and conversion into other products. Finally, they are trying to find ways to integrate the above technologies together.

2.6.6 U.S. DOE Energy Earthshots Initiative

The U.S. Department of Energy started an initiative to strive for the innovation of more abundant, affordable, and reliable clean energy solutions within the decade to help address the climate crisis. The first ‘shot’ of the Earthshots is the Long Duration Storage Shot which aims to reduce the cost of grid-scale energy storage to ultimately capture and store more renewable clean energy for later use. An example of this is storing solar energy for use at night. The second ‘shot’ is the Hydrogen Shot which aims to reduce the cost of clean hydrogen production by 80% for wider use of reliable clean energy solutions. The third shot is the Carbon Negative Shot, which pushes for new technologies that effectively remove CO_2 from Earth's atmosphere and store it safely at larger scales for less than $100 per net metric ton of CO_2 equivalent.

2.6.7 Carbon capture

There are many ways to effectively capture carbon. Some natural and technology-driven examples include direct air capture and storage, planting forests of trees to naturally capture carbon dioxide, ocean fertilization, and more. The next slide dives into this a bit further.

2.6.8 Direct and indirect capture

Using chemical reactions, carbon dioxide can be captured from the air or seawater and bound to a material or turned into a mineral like calcite for storage.

2.6.9 Storage in reservoirs
One way to store large quantities of carbon is by capturing and transporting it deep below the Earth's surface where it can be stored in geologic formations. Site options include saline formations, deep unmineable coal seams, and depleted oil and gas reservoirs. The image on the right shows layers of the Earth and the infrastructure to capture CO_2 at Earth's surface and to transport and store it safely deep underground.

2.6.10 Storage in materials and products
A useful option for captured carbon dioxide is incorporating it into materials and supplies currently on the market, like concrete, bricks, and other products.

2.6.11 Example of CCS in action
An example of carbon capture and storage, or CCS, in action is the Sleipner carbon dioxide injection project off the coast of Norway. This CCS project captures and stores CO_2 underground in a saline aquifer to avoid polluting the atmosphere. Over 16 megatons of CO_2 have been injected since 1996, and geophysical monitoring shows it stays safely in the geologic formation below. The findings from this CO_2 capture and storage project and over 20 years of monitoring have helped to create guidelines for future projects. This process keeps a lot of the CO_2 out of the atmosphere.

2.6.12 Carbon sequestration chemistry
Chemistry is closely associated with every one of these technologies - from capturing atmospheric CO_2, to understanding the geochemistry involved for geologic storage, converting it into useful downstream products, and harmonizing it with current and future industry technology. Therefore, the participation of chemists and chemical engineers in both the science and policy aspects is essential.

2.6.13 Net-zero vs. zero-emissions
Two more common terms that are used in mitigation and adaptation planning are net-zero and zero-emissions. Click the blue ‘turn’ icon to read the definitions of these two important terms and see how they are different.

2.6.14 A note about zero-emissions
An important consideration for the term zero-emissions is the boundary that defines something as zero-emissions. Defining and clearly outlining this is a critical point, especially for policymaking decisions. As an example, an electric vehicle itself can be zero-emissions, but looking beyond that, unless the energy used to power the vehicle is from carbon-free sources, there are still emissions associated with it and therefore it is not a zero-emission form of transportation.

2.6.15 Reducing emissions by sector – energy, agriculture, forestry, buildings
This IPCC graph shows both the calculated cost over a lifetime to switch technologies and the potential contribution to reducing net emissions by 2030. The information provided is in terms of Gigatons of CO_2 equivalent per year for the energy, agriculture, forestry, and buildings sectors. AFOLU noted on the graph stands for agriculture, forestry, and other land uses.

On the graph, blue indicates a low cost over the lifetime, red is higher cost. Here, all items contribute to emission reductions in some way. Wind & solar energy, carbon sequestration in agriculture, and reducing conversion of forests can have a major impact in reducing emissions.

2.6.16 Reducing emissions by sector – transport, industry, and others

This second IPCC graph also shows both the calculated cost over a lifetime to switch technologies and the potential contribution to reducing net emissions by 2030. The information provided is in terms of Gigatons of CO_2 equivalent per year for the transport, industry, and other sectors.

Low-cost mitigation options include shifting to public transportation, bikes, and increasing fuel efficiency. In industry, switching to a different fuel and increasing efficiency of energy and materials can contribute to mitigation. Reducing emissions of fluorinated gas can also have a big impact.

2.6.17 Carbon credits

A common term used in mitigation and adaptation planning as potential technology and policy solutions is carbon credits. A major issue with this is the logistics of tracking which emissions are offset where, and holding businesses that sequester carbon accountable for not making deals with multiple businesses about the same volume of carbon. Click the blue ‘turn’ icon to read the definition of this important term.

2.6.18a Transition

In the next section, you will think more about how climate change is impacting your own community.

2.7 Your locality and climate change

Please take a moment to reflect on the material covered regarding impacts from climate change and provide an answer to at least one of the following questions: How is climate change impacting your community or how do you expect it to impact your community in the future? What do you see as the most difficult barriers to mitigating or adapting to climate change in your area? What are you and your local policymakers doing to make your community more resilient to climate change? Click on the ‘reply’ button on the lower right side of this screen to make a new post. Once you provide your response, be sure to reply to someone else’s response to gain a sense of what other participants think. Following this activity, you will learn more about ACS' climate change policy statement.