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An Interdisciplinary Discussion on Climate Change

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Climate change is already leaving observable and lasting scars on the environment, from rising sea levels to disrupted plant and animal ranges. However, its impact extends far beyond the obvious, into every aspect of daily life. This article explores often-unnoticed implications of climate change, particularly on human health and medicine, city planning and housing policies, and ecosystem stability. Three Professors from the University of Louisville, whose research has led to interesting developments in these areas, have offered their knowledge on actionable steps that can be taken to promote environmental health and mitigate the adverse outcomes of climate change.

Dr. Timothy O'Toole is an Associate Professor at University of Louisville School of Medicine's Division of Environmental Medicine. While his past work primarily concerned molecular and cellular biology, his focus has since expanded to investigate whole organism-based physiology. Specifically, his lab largely studies how air pollution and volatile organic compounds (VOC's) impact cardiovascular and immune health. A particular area of investigation in Dr. O'Toole's lab is that of particulate matter (PM), which can be categorized as PM₁₀, PM_{2.5}, and PM_{0.1}. Dr. O'Toole explained that "PM₁₀ are rather large particles— sand grains—they don't go very deep into your lungs..." but "more health outcomes are linked with PM_{2.5} – combustion by products of car fuels, cigarettes, they go further into your lungs, and there is evidence that they can even pass into blood vessels. There are also ultrasmall particles, and they are very hard to study." As the human race continues to release more particulate matter into the air and accelerate climate change, we can observe the negative health consequences.

Dr. O'Toole gave an example of studies conducted in Mexico that discovered children demonstrated many developmental and cognitive defects from the constant exposure to high levels of air pollution. In fact, his own lab previously found that exposure to PM_{2.5} resulted in endothelial damage as well as changes

in immune cell populations and plasma cytokines in humans. This exemplifies the numerous impacts PM can have on our health without us necessarily realizing it.

As the issue of climate change worsens globally, it is becoming increasingly important to become more aware of and mitigate the negative outcomes associated with it. Dr. O'Toole emphasized the importance of raising awareness not just among the general community but also within the medical community. He explains the implementation of a new Division of Environmental Medicine here at UofL; further, UofL offers a summer program for medical students interested in exploring the influence of environmental pollution on health.

Dr. O'Toole also highlighted the importance of greenness. Currently, he is involved in a study with the Green Heart Project and Environmental Institute in Louisville that will plant trees and shrubbery over the course of 5 years. This study will measure biomarkers in blood and urine before and after planting to see if cardiovascular disease is minimized as a result. He also explained his involvement in a study where people are given carnosine, a naturally occurring protein building block, which has protective antioxidant effects. Dr. O'Toole stated, "any antioxidant— even drinking more grape juice— will be able to help you

[decrease risk of PM related health injury]".

Ultimately, our interview with Dr. O'Toole helped us to better understand the negative health consequences of air pollution. We also learned of the important work Dr. O'Toole and his lab are undertaking to better understand the mechanisms through which PM affects our health, as well as potential means to limit this oxidative stress. We hope people particularly remember the important small steps we can take to start mitigating these effects: raising community awareness, planting more trees, and increasing antioxidant intake.

The climate change conversation extends beyond the biological perspective and can be framed in the sociological outlook as well. We interviewed Dr. Lauren Heberle, the Director of the Center of Environmental Policy and Management. In recent years, her research has been merging interests in environmental justice and decision making with housing policies. Her work with reusing contaminated properties has "always touched on housing policies", specifically how and where houses should be built and how close these houses are to contaminated properties. Dr. Heberle explains that it "comes down to a 'chicken or the egg' scenario" with housing and contaminated properties and looking at this history allows for an understanding of how we got to where we are today. She sums this up as,

“How and where we build has an impact on the environment, how and where we decide to live, what we build our houses out of, what we put in our houses...”

Housing policy research is environmental research, and this work helps people understand how we got to where we are today in order to not keep doing the same thing over again. She explained that we have control over all of this, and we're seeing this now with the affordable housing funding that the community is getting. The question then arises as to whether or not this will be done in an equitable and environmentally conscious manner.

With housing and environmental justice comes environmental health. As the lead investigator for the Community Engagement Core at the University of Louisville Superfund Research Center, Dr. Heberle explains that much of her field is interposed with medical science -- applying environmental health research to a more clinical perspective. For those working in a health science field, it is important to understand the complexity of policy making; clinical research is irrevocably tied to constitutional and policy powers. With regards to climate change, there are many solutions that can be curated to address the harms that marginalized populations are more likely to experience; these factors are important for medical researchers to take into consideration. When asking questions about a patient's history, it is important to understand potential environmental exposures and stressors. Asking questions about these factors along with the typical patient intake questions could help physicians better understand environmental stressors impacting a patient.

The question of climate change and its effects is so broad, Dr. Heberle explains, but in the context of what we're seeing in Louisville right now, we have “increased flood events... increased severe storm events... we're becoming wetter and wetter, and we also have the issue of the urban heat islands.” According to Dr. Heberle, an urban heat island is the direct consequence of having such large amounts of concrete in an area that it results in the trapping of heat. The flood risk and heat islands are posing major concerns in Louisville; however, the city is attempting to ameliorate these issues by implementing new policies and improving the urban tree canopy, which is the layer of tree coverage that can be viewed from above. This tree canopy is important because it directly contributes to the clean air requirements in cities, thus improving the overall quality of life of a city's residents. The urban heat island effect and its methods of mitigation are still being studied, but potential solutions could include planting more trees, painting roofs white, building green roofs (planting greenery on rooftops), and creating rain gardens.

To summarize what Dr. Heberle's interview taught us, housing work is a fundamental piece of environmental health, along with the general health and well-being of the people in our community. Environmental health is important for physical health, which is why it is important for medical professionals to take this into consideration while doing patient intakes. There is a significant amount of work that needs to be done in order to control and decrease the damage we have already done to our climate, but this is not impossible and could definitely be achieved.

Like her colleagues, Dr. Maegen Rochner let her love for learning and nature lead her to becoming a professor of geography at the University of Louisville. She found her passion studying dendrochronology — tree-ring science — and has a wealth of expertise in the subject to

contribute to the climate change discussion.

Dendrochronology can tell scientists like Dr. Rochner how trees have grown over time and what may have impacted tree growth. Disturbances like weather conditions and other ecological changes are evident in tree-rings and can be an indicator of climate change. Dr. Rochner has done research on the effect of climate change on whitebark pines. These trees are considered a keystone species, which Dr. Rochner describes as a species that holds the ecosystem in place. As a result of warming temperatures, whitebark pines have been experiencing outbreaks of pine beetles and an invasive fungus. This is leading to a decline in the whitebark pine species, which will be felt across the ecosystem.

Taking into consideration that many ecosystems are already facing consequences from climate change, Dr. Rochner is doing research specifically regarding urban heat islands and the effects of climate change on urban forests. A heat island is experienced when urban areas have significantly higher temperatures than their surrounding areas. Urban forests and green spaces help mitigate heat islands by providing more reflectivity, cooling the environment down through evapotranspiration, and providing carbon sinks. Certain trees are more equipped to cool surrounding areas and are more resistant to drought and heat than others, which has led Dr. Rochner to investigate the types of trees that work best to properly mitigate the issue. To do this, Dr. Rochner has been comparing the growth and climate response of urban and rural trees. She has noticed that the rural trees, although in several different parks, have similar growth patterns to urban trees. Both urban and rural trees are shifting in how they respond to climate. This could mean that the negative consequences of the urban heat

island haven't been enough to cause a significant effect on tree growth in the city, or that the trees are more affected by regional scale impacts like climate change. However, this needs to be observed on a cellular and molecular level, which is what she plans to do next.

Trees are often referred to as natural proxies — recorders of environmental history before there was the technology to do so, giving background about previous fires, floods, freezing events, and more. All of this can be used to put what is happening today in perspective,

"The climate change we're seeing right now has never been seen in the geographic record before,"

Dr. Rochner stated. To mitigate this crisis, it will require policy to protect existing green spaces, promotion of environmental justice and equity, more grassroots effort, and active societal involvement.

These interviews have provided fresh perspectives on the wide-reaching impacts of climate change on our lives. We encourage everyone to be more mindful of their role in this process and become active participants in the fight against climate change. Please reach out to Dr. O'Toole, Dr. Rochner, and Dr. Heberle for any specific questions about their research; each of their faculty pages are linked below.

Dr. Timothy O'Toole:

<https://louisville.edu/medicine/departments/medicine/divisions/environmental-medicine/faculty/otoole-timothy>

Dr. Maegen Rochner:

<https://louisville.edu/geogeo/our-people/profiles/meagen-rochner-ph-d>

Dr. Lauren Heberle:

<https://louisville.edu/cepm/staff-and-associates/lauren-heberle>