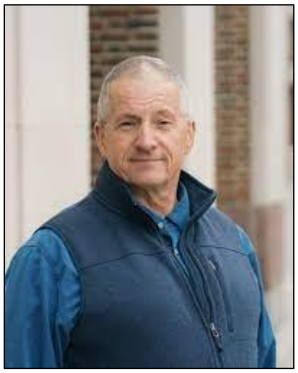

Navigating Climate Change and Extreme Heat in Study Abroad

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Of all the lessons from the pandemic, two stood out that we need to apply to the increasingly concerning problem of climate change related natural disasters. After months of unprecedented wildfires, flooding, and extreme heat events, we are just now heading into the peak of the Atlantic and Eastern Pacific tropical cyclone seasons with a recent category 4 storm hitting Florida a couple of weeks after a deadly tropical storm system (the first in 84 years) made landfall in Southern California. While these strategies have application to most of the fastest evolving hazards we face, we'll focus here on extreme heat.

The first lesson is the Swiss Cheese Model (metaphor) of risk management. Multiple layers of risk management are needed to significantly reduce the likelihood that health, safety, and security events will disrupt our programs or harm our participants. That may not sound particularly profound until you consider that the model became popular only after multiple failures to operate during the pandemic by schools, camps, professional sports teams, and the US military. They had all been managing risk the way we usually do. They put some reasonable measures in place. And then failed.

The second lesson is to identify, access, and apply good data. We need to understand how the hazards work and where and when we are most likely to encounter them. We can then figure out how best to prevent and avoid close encounters with them and understand what the options might be if we do encounter them.

Every calamity that vies for our attention requires new vocabulary. Study abroad risk managers sounded like epidemiologists during the pandemic with *variants, heat map, incubation period, asymptomatic, herd immunity*, etc. rolling off their tongues. With extreme heat events, we'll soon be integrating *web bulb, El Niño, thermoregulation, heat dome, anti-cyclone, conduction, convection, radiation,* and *evaporation,* etc. into our lingo.

What are the layers we need to identify, develop, and apply? First, it is useful to understand human physiology and heat. Many scientists believe that it was our evolution in response to heat that allowed humans to dominate their environment despite being slow, weak, and lacking in formidable claws or teeth. We evolved on the savannahs of Africa to be highly efficient heat management machines that could run long distances while maintaining a core body temperature within a relatively narrow range. We could successfully run down game over long distances that were much faster than we were over short distances.

Standing up allowed us to be cooler than other primates who travel using both hands and feet. We developed networks of more and better sweat glands throughout our bodies. We lost most of our body hair to allow for more efficient sweat evaporation but kept some on our heads to protect our brains from heating up too quickly in the sun. When our core temperature rises or falls, a bundle of cells in our lower brain senses it and sends a message to specific glands in the endocrine system. They in turn release hormones that create a heat response. In a heat response, our blood vessels dilate to bring more blood to the surface for cooling. Additionally, we begin to sweat and when that sweat evaporates it creates a strong cooling effect. A few degrees above 98.6°F or 37°C and we start to feel bad. Seven degrees or so above 98.6°F (or 3.5 degrees above 37°C) and we start to die. Danger is in the ambient temperature (if the external temperature is above 98.6°F, we don't lose any heat via vasodilation), and humidity (if there is too much moisture in the air, our sweat doesn't evaporate).

Let's divide our strategic slices into prevention, avoidance, and response.

Prevention

First, we might strategically choose when to go to places that have a higher likelihood of dangerous heat keeping in mind that "extreme" is a relative term. What might be extreme heat in one locale might be a typical summer's day in another. Choices would need to be informed by temperature data as well as an understanding of the culture and the infrastructure. In some places architecture and custom are organized around managing heat. Ceilings are high, walls and ceilings are thick, and no one works during the hottest part of the day. Clothing may be fully covering for sun protection but also lightweight and loose fitting. Some national and local cuisines have use of spicy food which can facilitate sweating and may help to keep people a little cooler. In places that are almost solely dependent on air conditioning, you'd want data regarding the resilience of the power grid.

Second, we might also consider who is more and less vulnerable to extreme heat. Babies and the elderly do not thermoregulate very efficiently. People who have a higher ratio of body mass to body surface area ("overweight") may be at significantly higher risk. Fitter people do better in high heat. Some medications inhibit vasodilation and sweating or are diuretics making it challenging to stay adequately hydrated. Culturally, we have a strong bias for facilitating participation in all activities without consideration for personal characteristics, but it would be important to ensure that participants understand if they have greater vulnerability to extreme heat.

Third, anyone who is likely to be in a very hot environment should fully understand the physiology, and the options for both prevention and avoidance, and how to recognize the signs and symptoms of heat stroke and what constitutes an effective response (principles and methods of heat transfer). There are numerous recent stories about day hikers either underestimating the temperatures or the effect of those temperatures, and not making it back to their cars.

Avoidance

Being strategic about where and when to travel will reduce risk but given that some of the recent extreme heat events occurred in places that have never seen such events, it won't eliminate it. What can you do if you find yourself in extreme heat? You could develop plans and policies based on the wetbulb temperature, i.e., the combination of ambient air temperature and the relative humidity. You might choose to immediately travel to a cooler locale especially if your capacity for being able to stay cool during the hottest hours isn't completely reliable. You might modify your schedule by canceling anything planned that involved exercise or sun exposure. You might focus on resting and staying cool during the hottest part of the day and plan activities for nights when and if it is cooler. Ensure that you have plenty of water available. Dehydration will reduce your ability to sweat and will inhibit the dilation of your blood vessels. Base your plan around those who are least able to thermoregulate either because of medications, medical conditions, or body type. Don't get too far away from the necessary resources for responding to heat stroke. This may all sound just like basic common sense, but the multiple tourists in Rome this summer who fainted from heat syncope demonstrated our tendency to push our tolerance of the heat instead of letting the heat dictate our plans.

Response

While prevention and avoidance are by far preferable, it is critical to know what to do when someone gets dangerously overheated. The two primary medical problems with heat are heat exhaustion and heat stroke. Heat exhaustion is as it sounds. A person becomes lethargic, and they appear exhausted. They should stop doing any hard physical exercise, get out of the heat, cool down and rest. If they are dehydrated, they should certainly rehydrate. This isn't particularly dangerous, but lethargy may reduce the likelihood that they'll take the aggressive steps necessary to prevent and respond to heat stroke, which is very much life threatening.

When our core body temperature reaches about 40.5°C or 105°F we start to present with mental status changes such as disorientation, irritability, and confusion. If not quickly and effectively cooled, brain damage may result with an anticipated problem of increasing intracranial pressure (life threatening swelling). Our skin may have more color or less color ("pale" or flushed) or be wet or dry depending upon how dehydrated the patient may be. Cooling may be accomplished through our understanding of radiation, convection, conduction, and evaporation. We are constantly radiating heat during normal temperatures such that we maintain a micro layer of air around us at about 97 degrees. That micro layer may be washed away by wind or 30 times more effectively by water. Immersion in icy cold water is the most optimal way of cooling someone down but is rarely an available option during extreme heat events. If trying to cool someone in the ocean, a lake or a stream, care must be taken to prevent drowning, which is a not uncommon occurrence for people trying to stay cool during extreme heat events. Spraying a patient with water and turning a fan (or fanning them manually) on them will facilitate effective evaporative heat loss. Application of ice or very cold compresses to the back of the head/neck, armpits, groin, etc. does help to conduct heat away, but is not considered very effective in reducing core body heat rapidly enough. Administration of IV fluids by a medical professional is ideal for managing rehydration, but fluids may be administered orally if the patient returns to normal mental status after cooling. Patients who have experienced heat stroke should always be evacuated to medical care, the urgency of which will depend upon how disoriented they'd become and how fully and quickly they've recovered.

Similar processes for creating strategies for prevention, avoidance, and response need to be developed for each of the climate change related hazards we are more and more frequently encountering. In what specific ways are people harmed by wildfires, heavy rains, and tropical cyclones and how are they evolving? For instance, it has always been the case that storm surge was the most dangerous aspect of a hurricane/typhoon/cyclone, but as storms are forming up higher in the atmosphere and moving more slowly, sustained high winds and heavy rains are beginning to be of greater concern. One excellent use of AI that is currently being developed is helping to identify the places and seasons where dangerous hazards are most likely to be encountered. What are the considerations for individual participants owing to pre-existing conditions, e.g., many pre-existing respiratory conditions are greatly exacerbated by wildfire smoke? What educative pieces should be implemented for staff, students, and administrators? What policies and procedures around where/when to go or not go, when to suspend a program, when to modify activities, how to vet destinations and accommodations, how to respond when prevention and avoidance have failed and a group or individual finds themselves is in a region where fires, floods, tropical cyclones or extreme heat events are occurring?

The most concerning aspects of the hazard landscape in study abroad remain the most mundane. Motor vehicle accidents, mental health issues, crime, illness, etc. are the greatest threats to our students and staff. But the risks we are encountering are evolving and doing so with greater and greater rapidity. To continue to operate “as safe as it should be” will require that our risk management evolves as quickly.