

*Earth System Education – Moving from Susceptibility to Awareness and Action*

Powerful hurricanes in the tropics, strong thunderstorms accompanied by hail and tornadoes in the Metropolitan area, recurring wildfires in the west, lightning strike injuries and death, snow and ice storms which paralyze transportation, flooding that requires evacuation and interrupts our commute to work, extreme heat and humidity that kill many people, and other natural hazards all readily find their way into the news – and into our lives. Whether these occur today, yesterday, last week, or several years ago they leave indelible marks on those affected.

The collective consciousness of the dangers posed by the natural environment is well-tuned for most people in the United States and around the world. The costs to property, the lives cut short or changed due to injuries sustained in such events, and the disruptions to multiple economies provide ample evidence of their significance. At many times we can feel powerless against the forces of nature – particularly if we do not understand what is happening and why. Our simple awareness makes us susceptible. Education with awareness allows us to take action and reduce our vulnerability before, during, and after such events.

We often find ourselves responding to these phenomena at the moment they occur. Yet with some advance planning or preparation that we hope will suffice, we take some precautionary measures. Afterwards we look for answers or solutions to these inconveniences based on what we know from our personal experiences and education. However, when the situation exceeds our expectations, we do not quite know how to best respond. This is one of the reasons why we study and teach about the Earth in terms of its air, land, and oceans in the Department of Geology & Meteorology; part of the College of Natural, Applied, and Health Sciences at Kean University through curricular programs and the Center for Earth System Education.

In recent years, and indeed over the last several months, the Metropolitan area within the Boston to Washington megalopolis has seen a substantial number of weather hazards causing considerable loss of life and significant property damage. These have been notable for both their frequency and their intensity and how they impact our urban ecosystems. Much discussion on these types of events often focuses on global climate change, El Nino or similar patterns, and the ecological damages inflicted by the human population worldwide.

Unfortunately, this sort of an approach tends to lead to shallow or superficial arguments that lack a sensibility of analysis and responsiveness that are targeted to us personally. Instead our approach should be governed by an understanding of the impacts that the natural Earth system may have on us based upon its principle behaviors and our responses to those behaviors. This is the context in which ongoing discussions, with regard to global warming versus natural climate variability and the analysis of recurring cycles of weather; is most effective – and the most relevant to most people. This is especially critical in urban environments on a daily basis.

Every day the atmosphere provides many types of weather around the globe from rain to snow, beautiful sunny days, fog, windy conditions, and even rainbows. The weather we experience is simply a product of an atmospheric engine driven by the Sun due to the Earth's orbit and the distribution of land, water, and vegetation. While some regions may be more prone to certain

types of weather than others, in other words the “local” climate; the atmosphere is capable of producing just about any type of weather anywhere.

For example, while tornadoes are very uncommon in Alaska (or in Brooklyn), they have occurred; snow may fall in Florida; and repetitive flooding may occur in Arizona (or Newark), although it may be quite rare due to its occurrence or intensity and sometimes both. This inherent variability expressed by the weather and climate is often interpreted as “unusual” by our standards when we experience something “out of the ordinary” (or different from the average) or that takes place at a time and location we do not typically expect. Yet this is what the atmosphere does on a daily basis throughout the year.

More important than focusing on the apparent gloom and doom of such events, or having knee-jerk (or over-) reactions as to their causation, a clear and balanced understanding of our susceptibility to weather and climate is in order. This includes their attendant hazards and therefore demands that we develop an ability to act upon that knowledge personally. To be successful in this endeavor requires improved awareness of, and education in, Earth System Science. The over-riding issues are the safety of people through awareness and education, the protection of property, maintenance of economies, and the ability to adjust lifestyles in response to the Earth’s natural events, hazards, and cycles over time. Of these, safety by awareness and education is the most critical and is the focus of the Center for Earth System Education.

Awareness allows our rapid response in times of hazardous conditions, whether approaching or occurring; and education helps us to understand how, when, and why we should respond. In the first instance, the National Weather Service provides watches and warnings for protection of life and property. The broadcast and media community help in reminding the public about safety precautions and provides for wider distribution of the message. The private sector and local governments use similar information to adjust their operations (public or private) to conditions. Teachers of K-12 make use of the hazards as opportunities to help students learn about the workings of the atmosphere. To be sure, each of these communities does much more than what is listed here; these are merely some of the basic components of their efforts.

Why then does it appear then that we are so disrupted when any weather event occurs? Why does it sometimes seem that we are not as well prepared as we would hope to be, particularly when we hear forecasts of such events? Is it simply global climate change? Climate models since the 1980s have shown that a greater degree of variability in weather is expected with a warming climate. This is to be accompanied by the likelihood of more frequently occurring extreme events or those with greater intensity. In fact, many of the models have pointed to shifting climate patterns that alter the distribution and duration of temperature and rainfall (or snowfall) – and recent evidence supports that some of these have already occurred (or are in progress).

However, the point made here is not so much for the debate of the science of global warming or climate change, it is to understand the very nature of the problem before us – the point is that we are now clearly more susceptible than ever before to weather and climate events as well as their intensity and frequency. We must ask why that is. The answer is relatively simple if we think about expanding populations, the locations people choose to live in, the density of population centers, our variety of transportation systems, and the landscape of buildings and open space

today versus twenty; or fifty or even one hundred years ago. Also think about our tolerance of weather events and the tolerance of the infrastructure that was built for specific purposes and conditions rather than with regard to a more variable weather and climate setting or one that is prone to significant weather events and hazards. All of these suggest that our vulnerability has increased and continues to do so – and that we need to do something to address the problems.

Combine these factors and you generate continuous and sometimes catastrophic disruption on both the local and large scale (for example, New Orleans). In fact, the disruption is more obvious in urban settings, of which there are many in the Metropolitan area, as the urban ecosystem may be more fragile to certain “shocks” to the system, may magnify those impacts, or simply be unable to respond quickly or effectively enough to longer term changes in weather and climate. Yet we have always had ‘bad’ weather and climate. There have been many episodes over time and throughout history that attest to the influence of the atmospheric engine such as the defeat of Napoleon by the “Russian Winter”, the decimation of the Spanish Armada by hurricanes, the challenges of the Vikings and the Jamestown colonization efforts due to weather conditions and climate change.

How then do we treat what may appear to be an intractable problem – are there really any viable or sustainable solutions? Education is the key. We must understand the weather and climate hazards problem in the context of the Earth System in which we live and prosper. To understand, we must begin with basic observations, measurement, and monitoring of the atmosphere (as well as the land and the oceans). Data generated in real-time and over periods of time provide us with analysis in order to assess hazards and risks. These form the basis for prediction, response, and precautionary steps – including whether we can avoid, mitigate, or prevent impacts by applying various strategies of management. These are only possible if we have a comprehensive knowledge of the Earth System – in terms of how it works and responds – and our interactions with it. The better we understand these, the more readily we may construct alternative solutions and approaches to respond to the hazards of the atmosphere – and the land and sea as well.

Is this a job for scientists alone? Hardly, this approach demands the involvement of all sectors of local communities to develop and implement viable responses to weather and climate hazards and variability. To do this effectively requires that all are well-versed in the basic components of the Earth System (air, land, and water), how these interact and impact us, and how we impact them by our activities. This is achieved through awareness and education programs in Earth System Science that also draw upon the characteristic behaviors and properties of urban and other ecosystems. Only in this manner, through education and research, can we truly manage the natural ecosystems we live in, whether urban, suburban, or rural; and be able to respond to changes in the Earth System over time. If we choose not to do so, we simply become more vulnerable with each passing day.

*Acknowledgement*

Dr. Paul J. Croft has been appointed as the new Director of the Center for Earth System Education and is a faculty member of the Department of Geology & Meteorology, within the College of Natural, Applied, and Health Sciences; at Kean University in Union, NJ. The Center hosts speakers, holds workshops for teachers, and has planned to develop a “Roundtable Earth” community of stakeholders. Croft obtained his doctorate at Rutgers University in 1991 and his work includes research and educational endeavors related to operational weather conditions, forecasting, and climatology.

Croft’s research work has included severe weather, fog, snowfall, air quality, thunderstorm initiation and other topics. Much of his work has been in collaboration with students and has led to both conference presentations and publications. He has taught undergraduate and graduate courses during the last twenty years. He has made presentations to K-12 students and educators and provided information to newspapers and television stations. He has consulted on journal articles, proposals, air quality studies, textbooks, and fog.