

*Earth System Education – Urban Ecosystems for Teaching & Research in New Jersey*

With the continuing increased emphasis on climate change and variability, it has become paramount in most science classrooms to fully engage students in global issues of weather and climate study. Whether it be warming or cooling temperatures, drought or excessively wet regimes; or the increased (or decreased) frequency of various weather phenomena students are expected to be fully engaged and knowledgeable about impacts of the environment and our responses. The complexity of these responses is increased when sustainability is considered. These pose real challenges to the existing framework and infrastructure in place for classroom instruction concerning earth systems as well as our ability to properly convey the “right” messages about our environment as well as our susceptibility. In an effort to encourage dialogue with students, while maintaining scientific discipline and rigor, it is important to provide a stronger context that is tied to their situational experiences.

The state of New Jersey offers a wide variety of settings due to its natural and anthropomorphic landscapes. In particular, large segments of the population live in – or commute to – numerous urban centers in the region. Each of the landscapes plays a pivotal role in the experiences of our students, particularly when weather and climate are considered in terms of impacts. The local landscapes occur in close juxtaposition to one another and offer a rich trove of opportunities for inquiry and exploration of impacts by students that is unmatched anywhere else in the world. This is particularly true in coastal regions where the challenges of sustainability often conflict with leisure activities. When considered with regard to climate variability, a concept inherent in any climate change or climate related discussion; the unique urban ecosystems present in New Jersey give students a glimpse of both possible – and realized – impact avoidance, mitigation, and prevention in the context of sustainable systems.

High population centers represent living laboratories that may be studied by careful observation, tested with specific trials or experiments, evaluated in terms of responses; and considered by way of prediction and evaluation. Such an approach is not merely a simple checklist of features, text book samples or questions; nor staid assessments based on statistical information, demographics, or simulations. Rather, it is a robust and comprehensive method when oriented according to the impacts on people and their local environment from multiple points of view: socio-economic, political, cultural, psychological, ethical, and scientific. These provide an important basis for the engagement of students by personal motivation, self- or directed-inquiry, and problem posing and finding techniques. When also provided the reality of logistical constraints, the study quickly becomes one of disordered complexity that must be resolved in an equitable manner.

To effectively communicate these to students, a variety of educational awareness activities must be provided through classroom lecture, laboratory, and other additional experiences (e.g., field trips and outside reading). Students must not only examine the science and associated problems, they must plan a scope of work, discern the proper metrics to examine and assign, debate both methods of analysis as well as observational bases, and suggest common protocols. This includes defining ecosystems of relevance, scaling and interaction review, and making comparisons of urban systems with others in the geosphere. The need for, and the proper acquisition of, field measurements is thus centered about the need to engineer multifaceted solutions to address any hazards or problems in order to ensure adequate responsiveness by the system and the people who live within it and in a sustainable manner.

In order to maximize learning potential, the educational experiences must be rooted in research investigations and methodologies. Many facets of the urban ecosystem can be studied by direct observation, relational diagnosis, simple prediction (or testing), application, evaluation of the application, and identification of new (research) questions to be answered. Through an active partnership with Kean University, middle and high school students can begin to experience this aspect of ecosystem studies by working with undergraduate students majoring in the sciences. As a result, peer guidance will allow for more effective review of scientific literature (that is peer reviewed) and web-based information. It will also help students develop skills in ascertaining and differentiating between meaningful research (i.e. data, methods, results) that is supported by reliable evidence rather than anecdotal information and hearsay. In the process, they will also experience the nature of database design and development, mapping and analysis in space and time, proper statistical and spreadsheet use, and the need for effective communication.

The initial investment of effort is relatively simple: provide an observational component to the science classroom that takes into account all elements of the urban ecosystem (i.e. not merely the scientific facts or numbers). Simple instrumentation (or the use of online data resources) offers students a chance to collect their own data, work with it to determine what it ‘means’, and then make careful assumptions in order to further their analysis. The use of multiple data sets (e.g., by other students or schools or that available from federal and state agencies or bio-blitz and similar types of events) requires students to relate quantitative and qualitative information in order to conceptualize relationships. Such an approach is standard in both environmental studies and phenological studies of climate – and is crucial to student learning and ‘ownership’ of the self-teaching and life long learning process. Hands-on data garners a greater appreciation and understanding of the inter- and multi-disciplinary nature of science that is critical to cross-disciplinary investigations. It also provides a real context for numbers that have otherwise come from a ‘black-box’ approach.

To assist in the integration of urban ecosystems for teaching and research the Center for Earth System Education (CESE) supports two key goals for learning based on urban ecosystems:

- 1) Increased awareness and use of urban ecosystems as a resource for teaching, learning, and research activities.*
- 2) Understanding climate, climate variability, and climate change in terms of urban ecosystems impacts & sustainability.*

These may be achieved through various strategies within (1) Teaching & Pedagogy; Learning Experiences; and Research Partnerships. This can include science fair and Science Olympiad types of participation. In addition (2) Urban Ecosystem Climatology; Climate Variability and its Measurement; and Climate Change Impacts and Responses are necessary to secure scientific credibility and understanding by all students. To be effective these must include integration of science standards, community partnerships, and direct sponsorship for implementation.

The use of combined resources (e.g., CESE with other Kean University entities and outside groups) and offering of workshops, training, and symposia in a coordinated manner provides the stakeholder community with opportunities to improve student engagement – and thus performance – in science. The production of more cognizant and capable students equates in the future with citizen scientists who are able to be involved in decision-making in their community and on local, regional, and global scales.

The CESE has provided several programs for students, teachers, and the broader community to accomplish these goals including: “WHERE – UR – in New Jersey!”; “Weather & Climate Portal”; “Round Table Earth”; “The Working CORE”; “STAGES”; “KU EMPOWERS ME!”; “CARPE DIEM!”; and the “KU: WE CARE about NJ!” symposium. Each of these programs promote direct interaction among community members who serve as stakeholders to assist one another in the improvement and enhancement of the earth system education experiences and opportunities available to New Jersey K-12 students and the public. The “WHERE – UR – in New Jersey!” program (Kean University’s Weather Hazard Education & Research for Ecosystems of Urban Relevance in NJ) involves Kean University faculty and students across disciplines as they collaborate with one another as well as outside communities through observational data, conceptual and analytic diagnoses, modeling, and prediction. These focus on hazardous weather and the impacts of various atmospheric conditions with regard to urban locations. This is assisted by the Weather and Climate Portal website project and STAGES (Student Teaching/Training in Astronomy, Geology, and Earth System Science) which focuses on astronomy.

The programs above are offered through the CESE “Round Table Earth” experience which includes geosphere component study and phenomena from oceanography and marine science to geology and agricultural connections. These incorporate a “Working CORE” (Working in a Community of Outreach Research Experiences) of students that facilitate interactions and support efforts in earth system learning that may be self-sustaining with time. The focus on hazardous weather and the impacts of various atmospheric conditions with regard to urban locations will involve Kean University faculty and students across disciplines as they collaborate with one another as well as outside communities through observational data, conceptual and analytic diagnoses, modeling, and prediction. This allows Kean University students to continue their professional development through the “KU EMPOWERS ME!” program (Kean University’s Environmental Management by Portal Outreach for Weather Education and Research by Students with Media Experiences). This was made possible through the “Kean University: Weather and Ecosystem Monitoring, Assessment, and Prediction for Integration and Training” (KU: WE MAP IT) project which established the operational framework.

This supporting structure provides the basis for the “CARPE DIEM!” program (Collaborative Atmosphere for Research Practicum in the Environment: Direct Interactions, Education, and Modalities!) to work cooperatively and collaboratively with middle and high school students and their teachers to develop and complete research experiences. Collaborations include outreach and service activities that broaden student perspectives as they explore their interests in science and plan a college career. Students conduct a research project that they may present at their school. Projects involve relevant issues in New Jersey including hazardous and severe environmental conditions. In the process, students make use of their content and analytic skills according to their achievement of the science standards – at both the state and national level.



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