# Do plant cells hold the roadmap for surviving climate change?

19 July 2019

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Do plant scientists hold the key to saving vulnerable populations in a changing climate? How should plant researchers prepare to deploy their knowledge to maintain food security in the future—as well as to promote renewable energy, sequester carbon pollution from the atmosphere, and even synthesize medicine?

Between 2030 and 2050, climate change will cause about a quarter of a million deaths each year through malnutrition, infectious disease, and extreme heat, according to a 2018 World Health Organization report. Economic losses related to climate change are projected to be several hundred billion dollars a year in the U.S. alone by 2090. And we are losing species at the highest rate we have seen since the dinosaurs went extinct; a phenomenon that scientists have coined "the sixth extinction."

Carnegie's Sue Rhee and David Ehrhardt, along with NYU's Kenneth Birnbaum, argue that we must drastically improve our understanding of plant cell structure, function, and physiology in order to mitigate the assaults to human health, the economy, and the environment brought on by climate change. Originally published by *Trends in Plant Science*, their editorial calling for a Plant Cell Atlas is now part of Cell Press special collection on conservation. Today they are launching a project website calling for a kick-off workshop to convene leaders from diverse fields to brainstorm how best to create this community resource.

"This is an enormous challenge and the plant science research community must do everything that it can now to help the world prepare to meet it," said Rhee. "Creating an atlas cataloging all the various types of plant cells, the products they produce, and the materials they require for function would allow us to answer longstanding questions about plant biology that directly relate to food security and climate change."

Plant cells are special because they can convert the Sun's energy into chemical energy—sugars and fats—for food. This process, called photosynthesis, is fundamental to life as we know it on Earth. It is the reason our planet's atmosphere is oxygen rich, allowing us to breathe. It is also the baseline source of our entire food supply—directly through consumption of fruits, vegetables, grains, and other plant products, and, for meat eaters, indirectly through consumption of animals that ate plants themselves.

Lastly, photosynthetic reactions require carbon dioxide, which means that plants are taking up and sequestering some of the carbon emissions with which human activity is polluting the atmosphere. The world's existing plant life captures about one fourth of the carbon dioxide produced by human activities each year.

Plants are also remarkable in that many of them can withstand extreme environments that would kill most animals. For example, there are desert plants that thrive at temperatures as high as 116 degrees Fahrenheit (47 degrees Celsius), which is 12 degrees higher than the maximum temperature on a standard hot tub. How plants evolved to become resilient to such harsh environments and what tools they use to perform such astonishing feat remain a mystery.

"We depend on plants for the air we breathe and the food we eat, and yet there are fundamental questions about how plant cells are organized and function that remain unanswered," Ehrhardt said. "This has to change if we want to be prepared for the future."

Due to recent innovations in data science, artificial intelligence, biosensors, systems biology, gene editing, precision breeding, and microbiome research, the time is ripe for creating a Plant Cell Atlas, argue Rhee, Ehrhardt, and Birnbaum. They say that the endeavor will require plant scientists to team up with biologists from biomedical fields, as well as experts in nanotechnology, imaging, and scientific computing.

The Plant Cell Atlas will be accessible to individuals and groups throughout the plant science community, allowing researchers from a variety of fields to track plant cell activity and relate it to external conditions on a scale never previously achieved.

Rhee, Ehrhardt, and Birnbaum, along with Carnegie's Acting Director of Plant Biology, Zhiyong Wang and Stanford's Nick Melosh, will convene leaders from diverse fields to the project's kick-off workshop where they will discuss how to best construct this resource, determine the initiative's goals and vision, and brainstorm about how to clear potential hurdles. They believe the undertaking will benefit the entire scientific endeavor as well as society at large.

"We already have commitments from 40 top scientists in emerging fields to participate in the workshop," Rhee said. "We are particularly excited to have funding from the National Science Foundation to include 20 junior scientists—graduate students, postdocs, and assistant professors. We welcome applications from interested junior scientists on our website."

"This initiative will allow us to answer questions about maximizing plant productivity and resilience and minimizing the risks posed by environmental stressors," Wang explained. "But we need to start now, if we want to make an impact before it's too late."

**More information:** Seung Y. Rhee et al. Towards Building a Plant Cell Atlas, *Trends in Plant Science* (2019). DOI: 10.1016/j.tplants.2019.01.006

Plant Cell Atlas: www.plantcellatlas.org/

Provided by Carnegie Institution for Science