What does it take to conduct a global experiment on forests and climate change?

An interview with Stuart Davies, Director of the Center for Tropical Forest Science

In 2007, HSBC Bank donated an unprecedented US $100 million to four environmental organizations with the aim of combating climate change. This groundbreaking donation supports a revolutionary project: The HSBC Climate Partnership.

The total donation of $100 million was given to four organizations: The Climate Group to transform large cities into green cities; WWF to protect large river basins that support millions of people; Earthwatch to transform people through a scientific volunteering experience; and the Smithsonian Tropical Research Institute to conduct a global field experiment on forests and climate change.

What would you need to conduct a global experiment on forests and climate change? What is the relationship between forests, carbon, and climate change? To answer these and other ecological questions, we interviewed Dr. Stuart Davies, Director of the Center for Tropical Forest Science (CTFS), during a recent CTFS training workshop in Gamboa, a small town bordering the Panama Canal. Dr. Davies and 20 other forest scientists from Africa and the Americas had gathered there to learn how to use the CTFS network’s new database system, which allows network scientists to share, manage, and manipulate immense sets of data on forests and climate change.

Question: Could you tell us a little about the Center for Tropical Forest Science (CTFS)?

Stuart Davies: CTFS is a global partnership between the Smithsonian Tropical Research Institute, Harvard University, and dozens of other research institutions and forestry departments around the world. Our goal is to monitor tropical and temperate forests to understand how these forests are put together, how they function, and how they’re going to change in the future. The CTFS network began nearly three decades ago with the first forest-monitoring plot in Panama on Barro Colorado Island. Today, there are more than thirty plots in the CTFS network. We’re monitoring over 3 million trees of 7,500 species in 20 countries in Asia, Africa, and the Americas.

Question: What do scientists know about forests, carbon dioxide (CO2), and climate change and how these are related?

SD: First of all, we know that greenhouse gases are raising the Earth’s temperature. And we know that the major culprit is carbon dioxide, the concentration of which has increased 15% in the last 50 years. We measure it in the atmosphere directly; we know that has happened. We also have indirect ways of estimating the concentration of carbon dioxide in the atmosphere over the last 100,000 years. Those estimates show that the rate of increase in atmospheric CO2 over the last 50 years has been faster than it has been in the last 100,000 years.

We also know that forests eat carbon dioxide. That’s the substrate, the food they eat. They take carbon dioxide in through their leaves, and they produce carbohydrates. And that
produces things like wood and leaves and reproductive structures like flowers and fruit. So if they eat CO₂ and you give them more, it’s possible that they will take the additional CO₂ up. That’s a big question that we scientists are trying to answer: Will trees consume more CO₂ as the atmospheric concentrations increase and therefore help mitigate global warming?

**Question:** Will they? Do forests take up more CO₂ when exposed to increased concentrations of that greenhouse gas?

**SD:** The early evidence we have for that is not clear, to be honest. We have some evidence that forests will increase their uptake of CO₂, and that evidence comes mainly from the Amazon Basin. But we have other evidence from Asia that shows that maybe they won’t increase their uptake of CO₂. The reason is not very clear, but it may be related to temperature.

Tropical trees and plants are also very sensitive to temperature, not just carbon dioxide. When the atmosphere holds more CO₂, the atmospheric temperature increases a little, and that can slow down plant metabolism. In other words, increased temperature can slow down the rate of uptake of carbon dioxide. But we just don’t know for certain how forests are going to respond to these factors. Some may take up more CO₂ but others may reduce their uptake due to increased temperature. Because we know that temperature and carbon dioxide concentrations are increasing, it’s very important that scientists and foresters understand the relationship between these counterbalancing factors and their impact on forests. Fortunately, because of partnerships like the HSBC Climate Partnership—which brings together the expertise and resources of eminent environmental organizations—we are in a good position to understand how forests are responding to climate change today and how they will respond over the next several decades.

**Question:** How exactly will you detect forest response to climate change?

**SD:** By directly studying, measuring, and monitoring on the ground, in the forests, lots and lots and lots of trees—over 3 million—in many different places around the world that represent the climatic and environmental conditions of major regions of the world. In this way, we will be able to see how forests are responding to changes in climate. Large-scale, long-term, intensive monitoring of global forests is key to providing the data necessary for building models that will help us predict how forests will function and respond to climate change in the future.

CTFS has been doing this for a long time. Over the last 25 years, we have established over 30 large-scale monitoring plots throughout the tropics and parts of the temperate zone to monitor forests through time, to understand what they’re doing and how they’re changing in response to climate change. We have been very lucky to receive support from HSBC to study in great detail where forest carbon is stored—both underground and aboveground—and how that’s changing among seasons and among years. That information is critical to understanding how forests are responding and will respond to
climate change at all scales—from local to regional to global. That’s why we’re working in Asia, Africa, and the Americas; why we’re working in the tropics; and why we’re working in the temperate zone: to do critical science with dedicated partners to understand some of the big issues surrounding forests and climate change.

**Question:** Some have described CTFS and its research in the HSBC Climate Partnership (HCP) as the largest-ever field experiment. Just how large is it?

**SD:** As I said, it’s global. It’s being conducted around the world in Asia, Africa, and the Americas at more than 30 sites. We are talking about 1,200 hectares—over 2,000 soccer fields—of tropical and temperate forest being monitored. That scale is unprecedented in forest science—not only the global geographic scale, but also the level of detail, which is at the scale of individual trees. CTFS methodology has brought about a revolution in tropical forest research since the first plot was established in the early 1980s. Again, we are monitoring more than 3 million trees of more than 7,500 species in 20 countries around the world.

In addition to trees, we are now studying soils, insects, and other organisms that are more sensitive to climatic variations and therefore will enhance our ability to detect and study subtle but significant changes in climate. Our research that is part of the HSBC partnership is divided into three areas. The main foci are on (1) understanding the role of forests in the global carbon cycle, (2) comparing temperate and tropical forests, and (3) quantifying the environmental services provided by tropical forests.

**Question:** Could you describe those three areas of your research as part of the HSBC Climate Partnership?
Let’s begin with the carbon research. We are studying the movement, or flux, of carbon in forest ecosystems through time. In short, we want to know whether forests are net sources or net sinks of carbon. In other words, we’re trying to determine if they are storing carbon or releasing it.

Trees contain approximately half the total carbon in a forest ecosystem. The other half is under the ground—stored in organic matter, in the roots of trees, in decaying wood. So if we want to understand the carbon cycle of forests, then we need to look at the carbon both aboveground and belowground. And that’s what we’re doing: sampling forest carbon pools—stores, banks of carbon—and monitoring them through time. A big question that we want to answer is this: Is that pool, that standing bank of carbon in any forest, stationary? Carbon comes in, gets stored in wood, gets transported out into rivers, and organic products go out into river basins and so on. Or: Over time, does this carbon bank, or pool, gradually increase? Our HCP carbon research will help answer those questions.

Our second area of research involves comparing temperate and tropical forests and their responses to climate change. Some forest-climate models predict that temperate forests will respond more quickly than tropical forests to a changing climate. To test whether that is true, we are setting up large forest-monitoring sites in the temperate zone and comparing them to what’s happening in the tropics. In this way, we can directly assess the different responses of temperate and tropical forests to climate change. We’re setting up new plots in Maryland and Virginia in North America. We just established a plot near Oxford, UK. We’re also establishing temperate plots in southeastern Brazil and China.

The third area of research aims to quantify the environmental services that tropical forests provide. Our experiment in the Panama Canal watershed is the largest-ever field experiment of its kind. Because the Panama Canal is so important to world commerce and depends on the local Panamanian water supply, the setting is ideal for the experiment and for attracting the world’s attention to the importance of tropical rainforests in regulating the flow of water.

A big question that we are trying to answer is: How important are forests for regulating life-sustaining water in our cities and towns? To answer that question, we have planted 140,000 native and exotic trees, and we’re monitoring the quantity and the quality of water that they help regulate in the watershed. We’re also monitoring water in areas that are degraded, that are cattle ranches, as well as in old and young natural forest so we can compare the value of these different forests for water flows. In addition to water regulation, we are looking at how different lands—degraded, old forest, exotic plantations—regulate carbon sequestration, or uptake, and biodiversity conservation through time. This project is very unique. It’s an example, a global example, of how to understand the environmental services that forests and common land uses provide.
Do you have a question for Dr. Davies and the CTFS team?

If you have questions about CTFS or the HSBC Climate Partnership, please send them to ctrfs@si.edu. Dr. Stuart Davies and the CTFS staff will answer them.