Stroud scientists are leading a study of the Christina River Basin to understand the impact of centuries of settlement, deforestation, agriculture, and development on the carbon cycle. The research aims to settle scientific debate on whether human induced erosion modifies greenhouse gas emissions from the landscape and impacts climate change.

Photo: Leslie Kipp

Moving Freshwater Science Forward:

ESTABLISHING A CRITICAL ZONE OBSERVATORY IN THE CHRISTINA RIVER BASIN

In 2009, the National Science Foundation (NSF) awarded the Stroud™ Water Research Center and the University of Delaware a $4.3-milllion grant to establish a Critical Zone Observatory (CZO) encompassing the entire Christina River drainage basin, which includes four major streams: the White Clay, Red Clay and Brandywine Creeks and the Christina River. One of only six CZOs in the nation, these observatories have been established to apply the disciplines of hydrology, geology, and biology to address large, fundamental and complex questions about the Critical Zone — the area from ground water aquifers to the tree tops — that sustains most life on earth.

The new observatory in the Christina River Basin places the Center among an elite group of watershed scientists and will attract the attention and interest of earth surface scientists from around the world. "It's going to catalyze the kind of intense data collection, sharing, discourse and collaboration that really makes science tick, moving it forward in ways we could only dream of before," says Stroud scientist, Anthony Aufdenkampe, one of the project's leaders. He adds, it will place the Stroud Water Research Center at the hub of exciting new collaborations and developments in freshwater science.

Studying The Effects Of Human Induced Erosion On Climate Change

The Christina River Basin CZO is the only one of the observatories located in a densely populated area that has experienced extensive human development over a long period of time. Since they first arrived in the 17th century, settlers in the 565 square-mile Christina watershed have cut down its old-growth forests, tilled the fields they cleared, erected mills and factories along its streams and rivers, and built cities, highways, suburbs and shopping malls to serve a growing population of more than 500,000 people. Today, the watershed which is comprised of five counties and 60 cities and towns in Delaware, Maryland, and Pennsylvania, is virtually unrecognizable from its original state.

The scientific goal of the Christina River Basin CZO partners is to understand the consequences of this kind of development on a watershed's ability to consume greenhouse gases and mitigate global climate change. In particular, the team will determine whether processes involving large-scale soil erosion and stream transport increase the production of carbon dioxide or the sequestration of carbon in floodplain and coastal sediments, significantly enhancing our understanding of the role of inland waters in the global carbon cycle. "Carbon is transformed and destabilized at the point when soil leaves the terrestrial ecosystem and enters aquatic systems, as happens during erosion," says Stroud scientist Lou Kaplan. "What we don't know is how that happens, or the ultimate fate of the mobilized carbon. Understanding this could yield important information to the debate about climate change."

"Soils contain 85% of all the active carbon on Earth," states University of Delaware soil scientist Donald Sparks, principal investigator of the Christina River Basin CZO, S. Hallock du Pont Chair in Soil and Environmental Chemistry, and Director of the Delaware Environmental Institute. "The opportunity to combine our expertise in soil science at the University of Delaware with the expertise in aquatic biogeochemistry of the Stroud Water Research Center," says Sparks, "represents the type of scientific collaboration essential to address the complex and critical environmental issues on which the CZO is focused." To get a complete picture of how the interaction of carbon and minerals caused by erosion could alter the earth's climate — and the role humans play in the process — we need to take a whole

Centuries of development make the Christina River watershed the perfect natural laboratory to study how large-scale erosion processes transform and destabilize carbon, and the consequential effects of its respiration, sequestration and transport on the carbon cycle.

CZO team members will study the biological, chemical and geological changes to the watershed and incorporate them into a scalable, predictive model. Shown left to right: Stroud Water Research Center scientist Anthony K. Aufdenkampe, Donald L. Sparks, the University of Delaware S. Hallock du Pont Chair of Soil and Environmental Chemistry, Stroud senior research scientist Louis A. Kaplan, and assistant professor of Plant and Soil Science at the University of Delaware, Kyungsoo Yoo. Hidden from view: graduate student Chunmei Chen.

watershed approach," said Aufdenkampe. "With the huge amount of data that has been collected since the earliest studies in the 1950's," team member and Stroud scientist Denis Newbold continued, "the Christina watershed is an ideal natural laboratory to study biological, chemical, and geological changes caused by humans over time and to put all these activities into a scalable, predictive model."

Building The Data Infrastructure To Support 21st Century Science

Nineteen percent of the CZO grant monies are being directed towards the acquisition and implementation of critical technologies required to collect and share data, a requirement NSF designed to ensure that the data generated, and their overall investment, are both well leveraged. For example, collecting water chemistry measurements used to require a labor-intensive process that yielded a relative handful of measurements per week. The infusion of funding allows the Center to purchase and install six, new field-deployable dissolved organic carbon analyzers and other stream chemistry sensors in locations throughout the watershed. These new sensors will add a dozen new variables to data that scientists can collect and will transmit those data every three minutes, revolutionizing our understanding of stream processes. In addition, data processing time will be reduced from weeks to seconds, getting information into the hands of those that can use it virtually instantaneously. Says Audenkampe of the new technology, "This is a total game changer for us and every other scientist who will utilize the data output."

The new technology infrastructure will go far beyond serving the needs of scientists studying effects of human induced earth

movement on the carbon cycle; it will also give Stroud scientists, local agencies, and policy makers the tools to study water quality in a watershed that provides drinking water for more than half the population of Delaware and nearly all of Chester County, Pennsylvania. Data and results will be transferred wirelessly to an open, web-based platform accessible to anybody, providing a useful resource to all organizations that monitor water quality to maintain standards consistent with the Clean Water Act, including the Environmental Protection Agency, the US and Delaware Geological Surveys, the Chester County Water Authority, the Delaware River Basin Commission, which is comprised of representatives from four states, and the Christina Basin Water Quality Management Committee — whose representatives from 15 local, state and federal agencies are charged with providing scientific input to policy makers.

The tools and focus of the CZO will also establish an extraordinarily complete and integrated knowledgebase and monitoring network. This will be of great value to the scientific community at large, as well as the Stroud Water Research Center's Education department, which will translate its scientific findings into accessible language and public programs for students, teachers, and community groups.

Facilitating Collaborations That Will Move Freshwater Science Forward

Stroud scientists have been collaborating with their University of Delaware colleagues for years across a number of projects, including the study of earthworm invasion on the soil structure and hydrology of important North American forests. With the CZO, that long-term collaboration is further strengthened.

CZO status enriches both organizations with an increased ability to attract qualified post-doctoral researchers and graduate students, key individuals that provide the manpower and intellectual resources essential to research hypotheses, and produce and analyze data in every scientific organization.

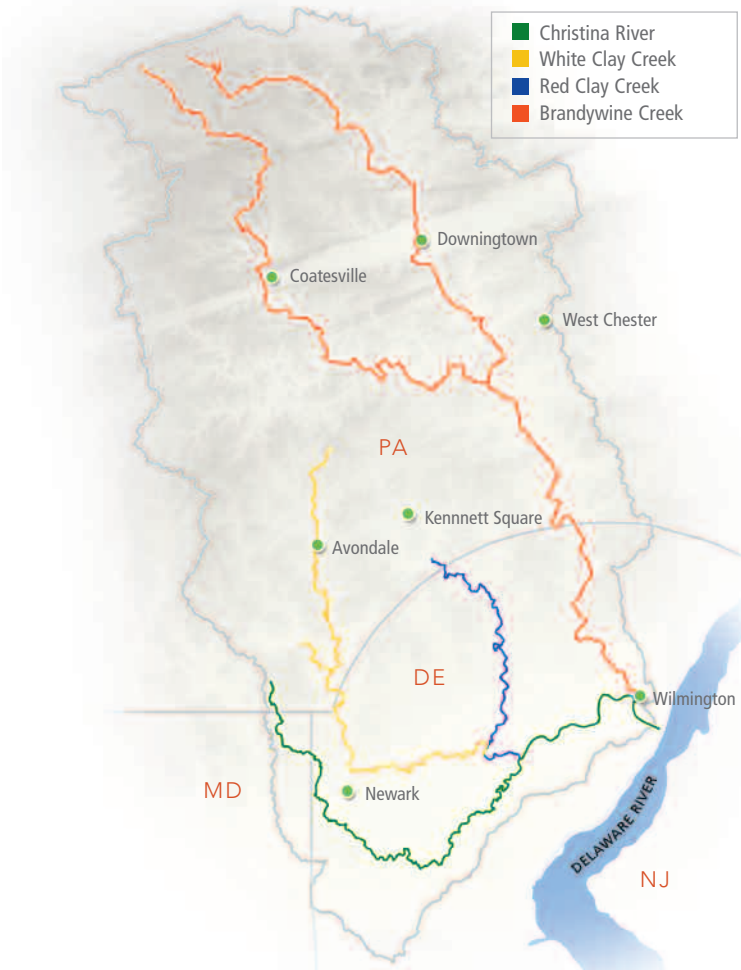
Already the CZO has enabled Stroud educators to collaborate with Penn State's Dr. Chris Duffy, whose watershed-scale numerical model is now being incorporated into *Model My Watershed,* a Web 2.0 educational project conceived by Stroud educators and scientists to teach students about their watersheds.

Also funded by NSF, this program is intended to increase interest in science, technology, engineering and math careers.

Finally, in addition to the CZO grant, NSF is providing incentives in the form of a new line of funding for other scientists across the nation to pursue research in collaboration with the CZOs, to leverage their datasets, infrastructure and expertise. This supplementary commitment guarantees visibility and will stimulate an ongoing stream of new collaborators, ideas, and proposals to bolster the potential for significant scientific discovery.

Links

- To learn more about the Christina River Basin Critical Zone Observatory, go to: http://www.udel.edu/czo/
- To read the news release in the University of Delaware's *UDaily*, go to: http://www.udel.edu/udaily/2010/sep/observatory092809.html



The 565 square-mile Christina River Basin, home to the CZO, provides the drinking water for more than half the population of Delaware and nearly all of Chester County, PA.