Interdisciplinary research looks at Charlotte's green mystery

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Charlotte, North Carolina is a rapidly growing city. Charlotte is also a green city. Some people might see that as a contradiction.

In Charlotte, there are wooded lots and remnant farms plots almost in the shadow of the towers of the nation's second largest financial center. There are also many sizable tracts of undeveloped land within the city's boundaries. Social scientists find the co-existence of strong urban growth and persistent green areas puzzling. The National Science Foundation thinks that Charlotte's complex environment might make an interesting site for long-term research in urban growth and sustainability.

After more than 12,000 years of civilization, more people now live in cities than in any other environment, yet our understanding of urban dynamics is still incomplete. Cities' paths to prosperity or failure, sustainability or decay are still mysterious to us because, like the humans that created them, urban systems are extremely complicated. For this reason, the NSF has been funding innovative, inter-disciplinary research aimed at studying the phenomenon of how cities grow and function as ecosystems, beginning with the 1998 establishment of two urban Long-term Ecological Research sites in Phoenix and Baltimore. Some important things have been learned, but now the NSF is considering establishing new study sites and is looking at 17 different cities as possible locations.

Researchers at the University of North Carolina at Charlotte have been awarded $300,000 by NSF's Urban Long-Term Research Areas

Exploratory Research Projects (ULTRA-EX) competition - one of 17 national awards given for pilot urban research projects. The exploratory projects are research trials that may lead to the later award of an ULTRA site - the establishment of a long-term study site with major NSF funding for urban-environment research.

Charlotte, which has experienced dynamic urban growth without losing all the pastoral charms of the North Carolina piedmont, may offer scientists an ideal living laboratory to study what makes a "human-dominated ecosystem" tick. "We have the opportunity to track and understand what is going on because we are catching Charlotte early enough in its growth trajectory," said Ross Meentemeyer, UNC Charlotte professor of Geography and Earth Sciences and the ULTRA-EX grant's principal investigator.

"Because of that we have a chance to determine if there are possibilities for alternative futures for Charlotte. Charlotte might be one of the best examples of a city projected to grow so fast and so big -- we have a unique opportunity here to watch development," Meentemeyer said.

If Charlotte's "city-in-transition" status makes it an attractive site to observe urban social and environmental dynamics, its conditions are also ideal for performing laboratory-like experiments in how the research findings might be applied and how urban change might be managed.

"The beauty of the situation is that if, working with public officials, we find a different course of action that can be followed, it could be very informative to the local stakeholders," Meentemeyer noted.

According to NSF, the grant will "provide support to enable teams of scientists and practitioners to conduct interdisciplinary research on the dynamic interactions between people and natural ecosystems in urban settings in ways that will advance both fundamental and applied

knowledge."

Meentemeyer, a landscape ecologist and Executive Director of UNC Charlotte's Center for Applied Geographic Information Science, heads the inter-disciplinary research team. Other members of the research group are Jean-Claude Thill, Knight Distinguished Professor of Geography and Earth Sciences at UNC Charlotte, who is an authority on urban systems and modeling, William Ribarsky, Chair of the Department of Computer Science and Director of the Charlotte Visualization Center, Chunhua Wang, an environmental economist from the Renaissance Computing Institute branch at UNC Charlotte, and Todd BenDor, assistant professor in the Department of City & Regional Planning at UNC Chapel Hill and an authority on land use planning and public policy.

While the project will perform basic research on urban dynamics and links between economic and environmental sustainability, the science will be tied to real life issues and will closely involve the ongoing work of local agencies and land management professionals. Grant partners include UNC Charlotte's Urban Institute, the USDA Forest Service, the US Fish and Wildlife Service, the North Carolina Wildlife Resource Commission, Catawba Lands Conservancy, North Carolina State University Forestry Department Extension, Gaston County Cooperative Extension, Catawba Regional Council of Governments, Centralia Council of Governments, Land Trust for Central North Carolina and Nations Ford Land Trust.

The Charlotte ULTRA exploratory project will focus particularly on the issue of the "persistence" of forest and farm lands within the urban boundaries. In Meentemeyer's words, the project aims to answer the essential question: "Hidden in Charlotte's current dynamic urban environment, are there alternative futures for growth where urbanization, forest and working lands can co-exist in an economic and

environmentally sustainable fashion?"

At the heart of the project is a two-year plan to develop a complex and sophisticated computer model that will allow the researchers and land planning partners to examine such "alternative futures" that might result from a wide variety of new variables - new laws and regulations, changing economic, political or environmental conditions, or emerging social and cultural forces.

Better Data Makes Better Models

Charlotte already presents a mystery that the researchers will need use the model to understand: according to researchers' and planners' basic theories of how economic forces drive land use, the city's many pastoral areas should have already been swallowed up by the surrounding development. Very curiously, they have not been.

"There's a top-down hierarchy of factors that should influence landowners' decision to develop, "Meentemeyer said. "Yet we often see locations where the development value far exceeds the human or ecological intrinsic value of the land but the forest or agricultural area still persists. Why is that? There is something going on there that we don't understand."

"It is really well-studied why things change," agreed Douglas Shoemaker, UNC Charlotte Center for Applied GIScience Director of Research, "yet we are seeing an unexpected pattern. Why doesn't everything go? In principle, urbanization and agriculture and forestry cannot co-exist, but, despite that, we see it in Charlotte. Why is a great research question."

The researchers believe that the secret to developing a model that can help analyze such complex urban development issues is to incorporate into the calculations not only all the complicated interconnected

variables of regulations, economics and physical or environmental conditions, but also something equally intricate and far more elusive - the values, attitudes and preferences of the unique group of people who currently own and occupy the city's landscape.

In order to get a realistic version of these very personal factors into the model, a major part of the research involves the sophisticated surveying of a large sample of the city's current landowners to get detailed information on their attitudes and values, which, when added with all the other data, will help the computer model predict how they would react in any number of hypothetical situations. In essence, the culture and attitudes of real people will become a critical part of an abstract, analytical system.

"We will use a set of methods that will get at people's motivations, not on the basis of actual choices, but to reveal their preferences with respect to hypothetical future situations," explained Thill. "That's pretty innovative and we'll try to feed that into some of the modeling later on. Once the model is put in place, we can try to look at some policies hypothetically."

Thill points out that changes in urban lands are controlled by both individual choices and larger, impersonal forces: "When you make the decision to develop your own land, that is a personal decision, but your action is also within the context of what is going on within the municipality, which has inferences as well from what is going on at the regional level, political and cultural influences, the tradition of the community and so on," Thill said, illustrating the human complexity of creating an accurate model.

"It is novel that we are using a survey-based analysis to guide the parameters of the agent-based model," Meentemeyer agreed. "Agent based models are trendy, but they are not always that well guided - they

are often very hypothetical. We want to ground ours with real data."

Complex Research Requires Interdisciplinary Science

Such a complex research project is possible because unusual connections have developed at UNC Charlotte across academic disciplines in natural, social and technological sciences that allow an interdisciplinary approach to the mind-boggling intricacies of interacting human and natural systems. A UNC Charlotte research specialty that comes into play is the university's Charlotte Visualization Center, a unique multi-disciplinary unit that studies advanced data analysis through developing visualization tools.

"A project like this involves tens, if not hundreds of variables," explained Charlotte Visualization Center Director and co-principal investigator Ribarsky. "We will need to look at the behavior of those variables as they interact - things like pressure to develop, which is influenced by a variety of conditions, combined with the effects of open land, the effects of resources like water and transportation and power… economic and social and cultural details also come into play. There are all of these 'dimensions,' as we call them in visualization research - they can all change the development pattern."

Ribarsky notes that the problem with complex interactions that involve a multitude of variables is that it is often very difficult to see and understand what the nature of the interaction is.

"We need to see how the dimensions behave with respect to one another and also how a growth pattern in one area correlates with a growth pattern in another area," he said. "Using visualization techniques, we will develop tools - 'probes' that will allow us to see how the variables are changing and developing and compare them to find differences for any regions we choose. The tools are highly interactive and can be used in an

exploratory way to help the researchers see the dynamics of the system they are studying - their use can reveal the detailed behavior of the model in a way that had not been revealed before."

In the end, the team hopes to develop a sophisticated model that will give land planners a very valuable and versatile tool with the ability to look into the future and to see with greater clarity the effects of a multitude of potential future conditions and policy decisions.

"It's a simulation," Meentemeyer said. "We can change the parameters any number of possible ways and then see what kind of human and ecological landscape gets created. This will allow us to understand what policies will actually work to build a more sustainable city.

"Decision makers can make policies, but no one knows right now if they are going to work. It's a tricky thing to try to figure it out. If we can help a bit, it will be an important contribution," he said.

Provided by University of North Carolina at Charlotte