



# Climate Variation:

## Answers From the Soil

BY TOMMY NEWTON



Dr. Mahmood

**TO BORROW A LINE FROM AN OLD COUNTRY SONG, DR. REZAUL MAHMOOD WAS CLIMATE CHANGE BEFORE CLIMATE CHANGE WAS COOL.**

His research, however, isn't directly focused on the hot topic of global climate change. For the past fifteen years, Dr. Mahmood has studied localized and regional climate change through several projects in hydroclimatology and agricultural climatology.

"Climate change has so many different facets, and you need to consider all of them," said Dr. Mahmood, who served as guest editor for a special issue on land use change and climate impacts published in 2006 by the journal *Global and Planetary Change*.

Dr. Mahmood's research has included soil moisture climatology of the Northern Great Plains, land use changes and their impact on climate, soil moisture variation and crop productivity, and monsoonal rainfall dynamics.

"I'm very interested in agricultural climatology and how soil moisture and temperature affect crop growth and yields," he said.

When the Intergovernmental Panel on Climate Change (IPCC) issued its first assessment in 1990, Dr. Mahmood was pursuing a master's degree in geography at the State University of New York at Albany. One of the concerns in that first report was the impact of climate change on agriculture production. The IPCC is due to release its fourth assessment report in 2007.

Dr. Mahmood decided to conduct crop and climate modeling related to dry season irrigated rice production under abnormally high or low temperatures in his native Bangladesh. His master's thesis in 1993 was titled "Climatic Change and Boro Rice Yield in Bangladesh: Application of a Parametric Crop Yield Model."

While completing his doctorate in geography at the University of Oklahoma in 1999, Dr. Mahmood took a look at the climate impact with a dissertation on "Monsoonal Rainfall Variability, Water Stress, and Rainfed Rice Productivity in Bangladesh."

In the latter project, Dr. Mahmood wanted to establish how crop yields varied by changes in rainfall. "If rain comes late, how does that affect the crops? And if the rain quits too early, what impact does that have?"

Dr. Mahmood continued his research on soil moisture variation as a post-doctoral research associate at the High Plains Regional Climate Center at the University of Nebraska from 1999-2001.

"In the 1990s the National Oceanic & Atmospheric Administration (NOAA) came out with new climate outlooks which provided a broadly-defined prediction of seasonal precipitation and temperature," he said. "These 'forecasts' heavily relied on sea surface temperature because two-thirds of our planet is covered by water. At this point, the scientific community started to ask the question, 'If water of the oceans is so important in climate prediction, then what about moisture in the soils

### ***If water of the oceans is so important in climate prediction, then what about moisture in the soils over land areas?***

over land areas?" Early modeling work started to show that when we include soil moisture in the atmospheric models their predictions improve."

In this context several large multinational soil moisture data collection and modeling campaigns were undertaken over six continents. With his background in soil moisture, Mahmood investigated various aspects of soil moisture as it relates to climate and weather. His work on soil moisture modeling and variations of soil moisture over various temporal and spatial areas still continued.

During these soil moisture related activities, Dr. Mahmood's research took a turn that he never really anticipated.

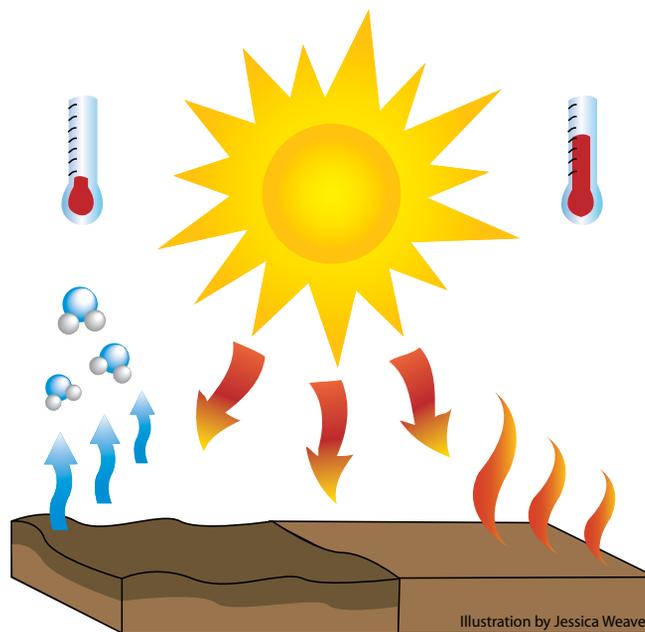
His modeling of soil moisture for the Great Plains included various types of land, including irrigated and non-irrigated. "It was very clear that the application of irrigation artificially increases near-surface soil moisture during the warm growing season," he said. "It also means that most of the incoming solar energy would be partitioned into latent energy and less into sensible energy. In other words, daytime temperature should be slightly lower in vastly irrigated areas compared to non-irrigated areas."

He thought this could be verified by analyzing long-term, near-surface air temperature data. Dr. Mahmood did just that and found a lowering of regional temperatures over the

irrigated Ogallala aquifer region of the Great Plains. "It must be remembered that this effect is confined to local and regional scales and there are other types of land use changes that could lead to warming of local and regional temperatures," he said.

WKU has provided the right climate — a tradition of academic excellence in meteorology, the Kentucky Climate Center, and high quality faculty and students — for Mahmood's research since he arrived on the Hill in 2001.

WKU's focus on undergraduate and graduate instruction provides an opportunity to engage students in hands-on research and learning.



*Large-scale irrigation of farmland affects the regional climate. Incoming solar energy converts soil moisture into water vapor and heats the soil less. In non-irrigated areas, solar energy is absorbed by the soil, increasing the near-surface air temperature.*



*Daytime temperatures are slightly lower in irrigated areas compared to non-irrigated areas*

“Teaching and research go hand in hand,” he said. “I’m able to use data collected from my research projects in classroom lectures and that’s very beneficial for students.”

Dr. Mahmood’s research now includes the study of flash flooding in the Appalachian Mountains, along with a USDA project on odor emissions from livestock farms and the Kentucky Mesonet project.

Recently, Dr. Stuart Foster and Dr. Mahmood received \$1.5 million first-year funding to establish a meso-scale weather and climate observing network in Kentucky. The Mesonet will gather information from a network of about one hundred stations across the state. “This project will take our department and the Kentucky Climate Center to another level,” Dr. Mahmood said.

The Mesonet will attract more students and will assist communities statewide with real-time climate and weather data. “We will be able to see the impact on people’s lives. This project combines service, outreach, teaching, and research,” he said. “I’m very excited about it.”

Through his classes, Dr. Mahmood identifies students who are interested in and excited about working with him on research projects. “At WKU, unlike larger schools, we actually tap undergraduate students, and I begin working with them in their second year,” he said. The students are eager to work on projects that affect their homes and families. In the flash flooding research, for example, students are trained in cutting-edge, three-dimensional modeling that simulates precipitation and its impact on a geographic region during various time periods. Students on that project and others collect and analyze climate data and present their findings at regional and national meetings.

“You need to give them confidence and encouragement,” he said. “It’s important that they stay interested and work at it. It’s their educational experience.”

Several years ago, Dr. Cathleen Webb, head of WKU’s Chemistry Department, and Dr. Mahmood were awarded a highly competitive Research Experience for Undergraduates (REU) grant by the National Science Foundation. This grant, the first REU award for the Ogden College of Science and Engineering, allowed them to bring eight students each year from different parts of the country to spend ten weeks at WKU and participate in research with other participating faculty mentors. The REU activities, which have continued for three summers, have included WKU students each year and permitted them to interact with their peers from other parts of the country.

Dr. Mahmood’s experience began in his native Bangladesh. His interest in climate and meteorology began in high school when he chose a geography course as an elective class. He entered the University of Dhaka as a geography student. “By the end of my freshman year, I knew I wanted to do climatology,” he said. He also knew he wanted to teach and conduct research. After completing his undergraduate and graduate work at Dhaka in 1989, Mahmood came to the United States to pursue his Ph.D.

“I have been fortunate to work with good scientists and learn from them,” Dr. Mahmood said. “I’ve had good mentors and collaborators.”

Currently, Mahmood is actively collaborating with scientists from nearly a dozen other universities and research centers across the country. “These types of collaboration allow us to build large science teams and take ‘a good crack’ at important research questions.” ■