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Dust in the Wind

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Dust IN THE WIND

Civil engineering professor part of team researching effects of dust deposits on soil formation, water quality in Rocky Mountains

Natalie Mladenov hikes to an alpine watershed to collect a snow sample for her National Science Foundation-sponsored research on water quality.

What's in the dust that the wind can blow from place to place may not be just affecting air quality — it may affect water and soil quality as well.

That's why an interdisciplinary research team led by a Kansas State University civil engineering professor is studying the effects of wind deposition of dust and other particulates, such as pollen or bacteria, on water quality and soil formation.

Joining Natalie Mladenov, assistant professor of civil engineering, on the project are professors from the University of Colorado at Boulder and a geochemist from the United States Geological Survey. The team was awarded a three-year, $556,774 grant from the National Science Foundation in September 2011 to complete the research.

The team's project was motivated by newly found connections between atmospheric deposition and water quality. Mladenov and her team believe that dust deposition and other atmospheric aerosols might play a role in increasing nitrate concentrations observed in alpine streams. Nitrates are pollutants that can adversely affect mountain streams, which are an important source of drinking water. Previously, these alpine soils were nitrogen-poor, now they are nitrogen-saturated.

Measuring dust and other Aeolian, or wind blown, deposition is especially important in Colorado's Rocky Mountains, the site of the team's research, because of high rates of nitrogen deposition. The deposition of pollutants to alpine ecosystems can cause high nitrogen concentrations in streams. But there appears to be another driver of the high stream nitrate concentrations — a biological one.

"Over the long term, in particular over the last few decades, scientists have observed that nitrate has been increasing in alpine streams," Mladenov said. "Nitrate is a compound that is regulated in surface waters by the U.S. EPA. Even though the alpine stream nitrate concentrations are far from exceeding the standard, the fact is that they have been increasing."

These changes appear related to alpine bacteria and their additions to nitrate loading. The research team is investigating whether atmospheric deposition of other elements, namely carbon and phosphorus, may be stimulating different microbial communities in the alpine soils and whether these communities are supporting bacteria that produce nitrate. There are limited amounts of carbon in the alpine because of the lack of vegetation, so carbon deposited from the atmosphere could be an important subsidy for microbes living in barren soil, according to Mladenov.

The team's research is being conducted in the Green Lakes Four catchment in the Rocky Mountains. The catchment is the site of a National Science Foundation Long Term Ecological Research Station, which provides considerable historical data to build from. Records of microbial populations and soil and wet deposition chemistry can easily be coupled with soil, stream and atmospheric deposition sampling.

"Our team has been studying the microbial populations in these soils and has found that they are more abundant and active than previously thought," Mladenov said. "What we don't know is where they are getting the carbon they need to support themselves."

Interestingly, Mladenov and her colleagues have found that rain and snow contain fairly high amounts of organic carbon associated with dust, pollen and atmospheric pollutants that could fuel soil bacteria in alpine environments. This is why the team will also be performing experiments in which dust and other aerosols such as pollen are added and then tracking how microbial communities respond to the inputs.

"If we can determine whether atmospheric deposition is a major source of carbon to alpine environments and that this deposition serves as a food source to support bacteria in these environments, then we will have a better grasp of the full story," Mladenov said.

Thomas Barret Wellemeyer, junior in civil engineering, is an undergraduate research assistant working with Mladenov on the project.

If Mladenov and her colleagues find that there are key linkages between atmospheric deposition, soil microbes and alpine streams, this could affect water quality in headwaters, which are drinking waters for a broad portion of the population.

Mladenov's colleagues are also investigating whether atmospheric deposition may be an important contributor to soil in alpine zones. The team has evidence that deposition of dust in these very arid, barren, extreme alpine environments may be responsible for soil formation in addition to weathering processes.

The team's grant will support assistance on the project by several graduate students at both the University of Colorado and Kansas State University. Support also is provided for a high school student from Colorado's Math Engineering and Science Achievement, or MESA, program to lead his or her own small research project. The program facilitates research opportunities for underrepresented students in science and engineering.

"The supported students will lead their own small research projects, so they will have a contribution to the overall project," Mladenov said. "These types of projects are known to have a real impact on students by providing them with a vision of themselves as a future scientist or engineer."

The team has already submitted a paper on the project to Biogeosciences, an interactive open access journal of the European Geosciences Union. The paper is available on the journal's website: www.biogeosciences.net.

By Tyler Sharp, Communications and Marketing