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RESEARCH SERVICES

OFFICE OF POLICY ANALYSIS, RESEARCH & INNOVATION

TECHNICAL SUMMARY

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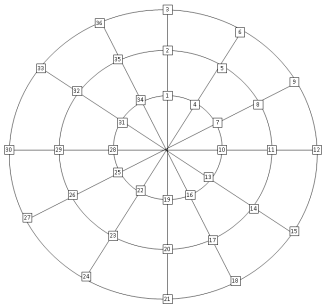
PROJECT COST:
$55,000



Metro 2001 Soil Survey data used concentric circles to define zones based on their proximity to the Minneapolis downtown area at the circle center.

Measuring Soil Contaminants Caused by Land Use

Researchers evaluated soil survey data to determine concentrations of potentially harmful chemicals in Minnesota soils while distinguishing the effects of human activity from those of native geology. They found that soils closer to roads and downtown areas had higher chemical concentrations.

What Was the Need?

After the completion of construction projects, the soils within the right of way may be subjected to chemicals contained in construction materials and recycled industrial byproducts used beneficially in the project. These chemicals include heavy metals such as arsenic and lead, and other contaminants that in large enough concentrations can be harmful to human health and the environment.

The Minnesota Pollution Control Agency determines the allowable concentrations of these chemicals. Determining these levels requires knowing the background levels of the chemicals in soils throughout Minnesota. In 2001 and 2003 Mn/DOT conducted statewide surveys to measure concentrations of 45 chemicals. To understand this data, analysis was required to distinguish chemical levels occurring naturally in Minnesota soils from those resulting from human activity.

What Was Our Goal?

The goal of this project was to analyze 2001 and 2003 statewide soil survey data to determine chemical concentration trends in soils within the Minneapolis metropolitan area and the state of Minnesota, distinguishing concentrations due to human activity from those existing in native geology.

What Did We Do?

Researchers analyzed three sets of data: 135 samples produced by the Metro 2001 Soil Survey, 200 samples produced by the Statewide 2003 Soil Survey and eight background soil samples collected by researchers near parking lots and minor city roads. Each sample was collected at a single location and contained 45 chemical measurements.

Researchers began by preprocessing data to develop strategies for dealing with outliers and sample measurements below known detection limits. Then they produced models consisting of self-organizing maps, which provide visual representations in two dimensions of data with a higher number of dimensions—in this case, a dimension for each of the 45 measured chemicals.

2001 data included samples collected at sites along Mn/DOT roads within the Minneapolis–St. Paul metropolitan area, including downtown, suburban and rural zones. Researchers modeled the way the concentrations of chemicals changed based on zone and distance from major highways both for the 2001 data and the background samples.

2003 data included samples collected throughout Minnesota that were representative of each of the state's terrain types as determined by historical geological processes shaping them, such as erosion, weathering, sedimentation and other factors. Researchers modeled the way in which chemicals were clustered within these terrain types.

Finally, researchers analyzed the relationship between 2001, 2003 and background samples to evaluate whether construction and other land usage were associated with increased chemical concentrations. Specifically, they analyzed data for high concentrations of chemicals that are dangerous to human health, taking care to use 2003 state-

continued

"These results can be used by engineers, toxicologists, planners and administrators at Mn/DOT and other state agencies to determine background levels of inorganic contaminants."

—Vladimir Cherkassky,
Professor, University of Minnesota Department of Electrical and Computer Engineering

"This study will help us assess the impacts of human activity on Minnesota soils and whether certain kinds of industrial byproducts are suitable to specific construction projects."

—Robert Edstrom,
Chief Toxicologist, Minnesota Office of Environmental Services

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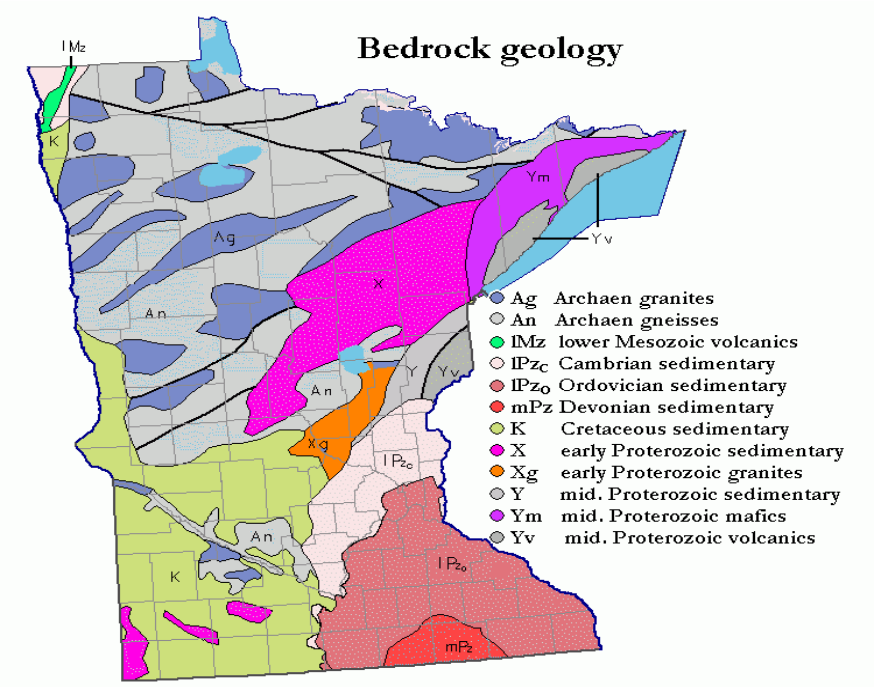

Important to evaluating the chemical profile of Minnesota soils is its bedrock geology. Because of its geological history, northeastern Minnesota has high concentrations of minerals that must be distinguished from chemicals caused by human activity.

wide data to distinguish those caused by human activity from those caused by native geology.

What Did We Learn?

Overall, the analysis indicated that chemical concentrations in soils adjacent to roads were higher for some elements such as lead, tungsten, zinc and copper. Chemical concentrations in soils generally decreased with distance from the road but not necessarily from the downtown areas.

Metro 2001 Soil Survey Data: Results showed that soil samples collected both in surveys and by researchers on the current project near roadways had higher concentrations of chemicals including lead, tungsten, zinc and copper than those farther away. These near-roadway chemical levels were consistent for soils with similar profiles, regardless of the distance of the collection site to downtown Minneapolis. These results suggest that concentrations of certain chemicals in metro area soils have been affected by local industrialization and that this effect is not easily discernable near major metropolitan roadways.

MN Statewide 2003 Soil Survey Data: Results showed that samples collected from northeastern Minnesota had higher concentrations of certain elements, including arsenic, chromium, copper, nickel and tungsten, than those collected from other parts of the state. Statewide concentrations were more similar to the background samples of the 2001 survey than the 2001 roadside samples.

What's Next?

Mn/DOT has defined the eventual end-user product of this ongoing research effort as an integrated data management plan for environmentally related information, and this project contributes to that goal. Its results will be helpful in determining the suitability of certain recyclable materials or products for use in construction or maintenance activities. The data gathered through this project provides a chemical baseline from which Mn/DOT will be able to detect trends in the chemical levels within soils throughout the transportation system. Participating agencies will be sent soil data via CD-ROM and a link for downloading the final report.

This Technical Summary pertains to Report 2010-22, "Statistical Analysis of the Soil Chemical Survey Data," published June 2010. The full report can be accessed at http://www.lrrb.org/PDF/201022.pdf.