NATURE|Vol 466|12 August 2010

Mountain mining damages streams

Study shows that stripping mountains for coal has a much greater impact than urban growth.

PITTSBURGH, PENNSYLVANIA

The controversial practice of stripping off the tops of mountains to mine coal, long suspected of polluting streams, is guilty as charged, scientists say.

On 3 August, researchers at the Ecological Society of America conference in Pittsburgh, Pennsylvania, presented what they say is the first conclusive evidence of a direct link between this type of mining and environmental damage. Their research has teased apart the effects of mountain-top mining and urbanization on local water quality in West Virginia, and found that even relatively small mining operations can cause serious harm to ecosystems.

"Even at very low levels of mining we found a dramatic impact on water quality and stream composition," Emily Bernhardt, a biologist at Duke University in Durham, North Carolina, and one of the study's lead researchers, told *Nature*. The scientists have called on the US Environmental Protection Agency (EPA) to tighten the water pollution limits faced by mining companies.

Mountain-top mining is widespread in eastern Kentucky, West Virginia and southwestern Virginia. To expose seams of coal, mining companies strip away forests and break up rock with explosives. The rubble is dumped in the valleys, often burying streams. The loss of vegetation and topsoil can cause flooding, and the water emerging from the debris contains toxic solutes including selenium, metals and sulphates, says Bernhardt.

The EPA recommends that mining activity should not increase the electrical conductivity of stream water (a measure of its ionic concentration) beyond 500 microsiemens per centimetre (μS cm^{-1}). Yet a previous study[1] demonstrated significant changes in the size and composition of macroinvertebrate communities — such as mayflies and caddis flies — at lower conductivity levels. A second study[2] found that increases in the concentration of metals in stream water, and decreases in stream invertebrate biodiversity, were correlated with increased sulphate concentrations, an indicator of mining. But neither study established a direct link between mining and the environmental changes.

West Virginia's mountains contain valuable low-sulphur coal.

P. SOUZA/CHICAGO TRIBUNE/MCT/NEWSCOM

"Even at very low levels of mining we found a dramatic impact on water quality and stream composition."

Bernhardt and her colleagues overlaid images taken by satellites and aircraft of mining activity in West Virginia's Appalachian Mountains onto topographic maps of the area, allowing them to estimate the amount of mining taking place in mountain watersheds between 1996 and 2009. The research team also had access to data on water quality and invertebrate biodiversity for 478 sites in the area, collected over the same period by the West Virginia Department of Environmental Protection.

Mining had occurred at 208 of those sites, where the average water conductivity was 650 μS cm^{-1}. In the most intensively mined areas, where 92% of the watershed had been mined at some point, conductivity levels rose to 1,100 μS cm^{-1}. Bernhardt says that even in areas where just 2.5% of the watershed had been mined, some 30% of streams still had conductivity levels greater than the EPA's recommendation. The team also noted "sharp declines" in some stream invertebrates in areas where as little as 1% of the watershed had been mined.

William Schlesinger, a biogeochemist at the Cary Institute of Ecosystem Studies in Millbrook, New York, says the results are "significant" as "they directly link changes in the stream water chemistry to the area of the watersheds that has been disturbed by mining activities".

The study also addresses the mining industry's contention that water-quality standards should not be tightened because stream conductivity changes often reflect urbanization and other changes in land use. Earlier this year, the National Mining Association (NMA), based in Washington DC, said in a statement: "No evidence has been presented that uniquely correlates higher conductivity levels with coal mining or valley fills."

In 202 of the sites Bernhardt and her colleagues studied, however, there was no mining activity, but some urban development. Water at these sites had an average conductivity of 228 μS cm^{-1} — much lower than the average at mined sites. In 30 other sites, no mining or urban development had taken place, and these control sites had an average conductivity of 105 μS cm^{-1}.

Bernhardt says she was "shocked" by the differences. But she declined to say at what level she thinks the EPA should set the threshold, saying only that "it appears you get effects at much lower levels of conductivity than previously thought". Luke Popovich, the NMA's vice-president for external communications, declined to comment on the study without seeing its data, but notes that the conductivity limit set by the EPA is "difficult or impossible for mining operations to meet. In our view, this begs the larger question of whether conductivity as employed here can tell us much at all about the impacts of mining on biodiversity."

"Conductivity should not be used as an exclusive tool for isolating impacts from mining activity from the many other sources or factors that may impact water quality," he adds.

In a statement to *Nature*, the EPA says it believes that the study's results are "generally consistent" with its own research, which is "currently being reviewed" by its science advisory board. "EPA will continue to rely on the best available science as it reviews proposals for new surface coal mining projects under the Clean Water Act," it adds. ■

Natasha Gilbert

1. Pond, G. J. *et al. J. N. Am. Benthol. Soc.* **27,** 717–737 (2008).
2. Palmer, M. A. *et al. Science* **372,** 148–149 (2010).