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Water and Mining Conflicts in Peru

Impacts on water quality and quantity are among the most contentious aspects of mining projects. Companies insist that the use of modern technologies will ensure environmentally friendly mining practices. However, evidence of the negative environmental impacts of past mining activity causes local and downstream populations to worry that new mining activities will adversely affect their water supply. We report on one mine site in Peru where water has become a particularly conflictive issue. We then provide a detailed proposal for a monitoring plan to recover trust among stakeholders. A well-designed and executed monitoring plan for water quantity and quality is critical to foster dialogue, consensus, trust, and transparency between mine and community.

Engaging with mining conflicts in Peru

The expansion of mineral extraction is accelerating in the Andes (Figure 1). Some experts calculate that over 50% of Peru's peasant communities have been affected by mining activities. Alongside optimism that this will lead to significant economic growth there is concern that the environmental costs might be unacceptably high. There are major stakes in these conflicts, affecting everything from local livelihood sustainability to the solvency of national governments. Fears for water quantity and quality have triggered numerous and sometimes violent conflicts between miners and communities.

One particularly conflictive site has been the Rio Blanco Project in the Department of Piura, located along Peru's border with Ecuador (Figure 2). This conflict involves a UK-registered company, Monterrico Metals plc; it has been monitored by various organizations, among them the Peru Support Group, a British civic association. Because of conflicting testimony in the British Parliament by the mining company and by local stakeholders in 2006, the Peru Support Group (PSG) agreed to form an independent delegation to visit the region and consider the nature of the conflict, its causes, and possible ways forward. The delegation involved a member of the UK Parliament, a journalist, a social anthropologist and the authors: Anthony Bebbington led the delegation and Mark Williams was the expert hydrologist.

The delegation engaged with the mining company, national government, and a range of national, regional, and communi-

FIGURE 1 View of the Yanacocha open pit gold mine in northern Peru—the largest and probably most profitable in the world. (Photo by Jeff Bury)

ty-level interest groups in an effort to understand the many dimensions of this conflict and identify ways in which addressing water and other issues might reduce levels of tension (Figure 3). Our report (see Further Reading) was presented at the UK Houses of Parliament on 27 March 2007, and at 3 public meetings in Lima and Piura in May 2007. These meetings were attended by community members and leaders, NGOs, mining companies, government officials, researchers, and the press, and involved debates on the report with the company, its legal advisors, NGOs, and advisors to the regional government. Here we focus specifically on our proposals for a water monitoring scheme that could contribute to more productive relationships between mining and development. We believe that this monitoring scheme is transferable to other proposed mining sites.

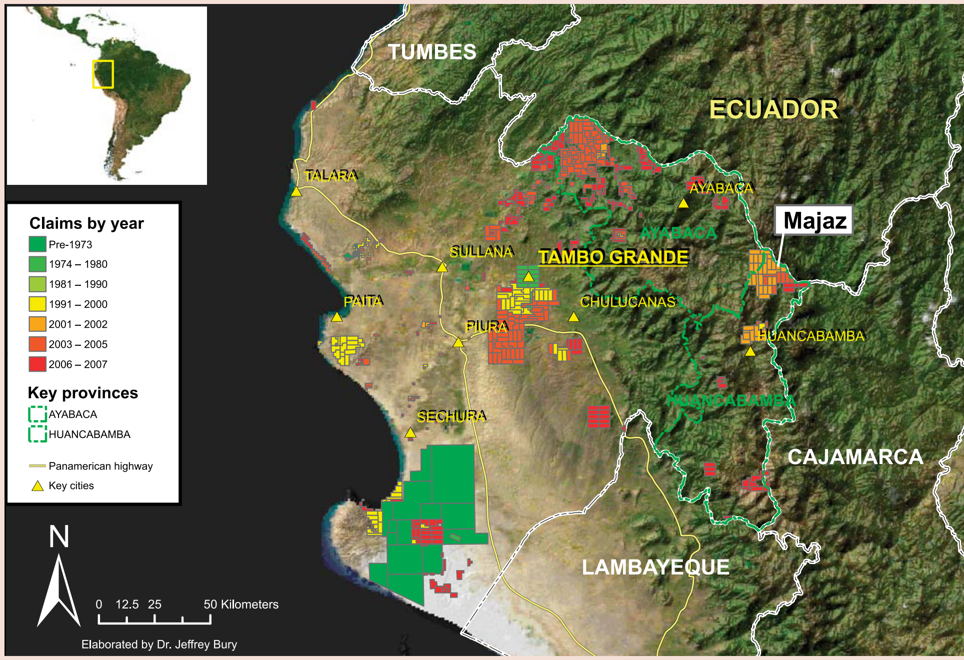

FIGURE 2 Increase in mining concessions in Piura. (Map by Jeff Bury)

Water and mining in Peru

Peru is South America's most water-stressed country. Water draining from the Andean highlands serves as a water tower that supports the downstream population and attendant agricultural activities, including the country's dynamic agricultural export economy. The Tyndall Centre for Climate Change Research identifies Peru as the world's third most vulnerable country to the impacts of climate change.

Further pressure comes from the rapid expansion of mining in Peru. While estimates are that mining uses only about 5% of Peru's water, this understates the significance of this use. First, many mining concessions are located in headwater areas in the high Andes; second, mining can adversely affect water quality, and these impacts on quality can extend well beyond the mine site, relayed across space by rivers and aquifers. They can also extend over time, lasting generations.

The impacts of mining on water quality and environmental health originate primarily from acid mine drainage (AMD) and the escape of ancillary products in processes of production and transformation. AMD occurs because rock is broken up during the mining process to gain access to the ore, and then deposited elsewhere on the mine site. The ore-bearing rock is then ground down much more thoroughly. After minerals have been removed, it is stored in tailings. The surface area of the rock exposed to air and water grows exponentially, increasing rates of chemical reaction, as a result of which contaminants are released into the environment. AMD involves the transmission of these highly toxic contaminants through the movement of water. In July 2008, Peru declared a state of emergency at a mine near Lima over fears that its tailings dam, weakened by seismic activity and subterranean water filtration, could release arsenic, lead, and cadmium into the main water supply for the capital.

It has been estimated that every year mining and metallurgy release over 13 billion m^3 of effluents into Peru's water courses. Consequently, though attracted by the possible economic benefits of mining, populations also worry about the potential for adverse environmental impacts and the implications that these will have for livelihoods, consumption, wellbeing and health. Many nongovernmental and community groups and urban environmental committees express significant concerns about water and mining, as does the office of the Ombudsman.

Nonetheless, government policy has encouraged the rapid growth of mining investment.

Other factors aggravate this situation. There is an overall absence of clear, reliable, transparent, and independent information on the nature of the risks at stake. Also, the long histories of poor corporate environmental practice and of weak state regulation have left communities distrustful of the central government and mining companies. These factors and others have driven escalating conflict over the last decade. This has been especially severe in regions where mining is a new activity. One of the most conflictive of these has been Piura.

Piura: a new mining frontier?

The Department of Piura stretches from the high Andes to the Pacific coast. The coast is made productive by several irrigation projects channeling Andean water to farms used both for agricultural exports and domestic food production. The highlands are home to poorer peasant communities whose economies combine market and subsistence agriculture, migration, and off-farm labor (Figure 4).

Between 1998 and 2003 Piura became famous in mining debates because of a conflict between the residents of Tambogrande and a Canadian company, Manhattan Minerals. Manhattan departed shortly after a local referendum in which over 93% voted against mining. Meanwhile, Monterrico Metals was beginning exploration work in Piura's highland provinces of Ayabaca and Huancabamba. This elicited similarly severe conflicts. Two farmers were killed during protests, while different national and international actors became involved. This conflict also led to a referendum held in September 2007, and again, over 90% of voters were against mining. But the company, the central government, and the President of Peru continue to insist that the mine go ahead.

One of the main concerns of local and downstream communities relates to the mine's effects on water quality and quantity. Activists and the company disagree on which drainage basins will be affected by the mine, and on the capacity of the company to control its environmental impacts. The conflict has reached such a depth that all parties appear to have lost trust in each other and nobody believes claims that others make. A way forward that is satisfactory to local farmers, other stakeholders, the central government, and the mining company is not obvious.

Establishing a system for providing transparent, independent, and trusted information on water quantity and quality will not resolve this fundamental conflict. However, the mining project will not proceed peacefully without such a monitoring system.

FIGURE 3 Consulting with stakeholders. (Photo by S. Paton)

Water management and mine design

A well-designed and executed monitoring plan for water quantity and quality is critical to foster dialogue, consensus, and trust between the mine and the community. Any monitoring conducted must be conducted in a transparent, publicly available, and inclusive manner. The monitoring plan should have the capacity to adapt to changes in mine operations as the mine grows, closes old operations, and explores new areas. Any monitoring plan must have a formal, independent, external verification program. We cannot emphasize this point enough.

The monitoring plan we propose draws on models already in place in Peru, such as the Yanacocha and Antamina mining projects. In all cases, the monitoring plans were enacted after complaints were formally filed against mining companies by concerned municipalities and citizens in response to perceived contamination problems caused by mining activities. We suggest, conversely, that monitoring plans be employed *prior* to and *during* mining activities, and not only after complaints have been made against the mine. We also differ in insisting that these monitoring activities *be verified* from the outset by independent, external organizations neither linked nor perceived to be linked to mining interests. Initiating a comprehensive monitoring project prior to the operation of a mine, through its life, and into its decommission phase has numerous advantages:

- Baseline information on water quantity and quality before mining activities begin provides data on natural conditions;
- Comparison of current conditions of water quantity and quality with baseline information provides a quantitative assessment of the contribution of mining to current conditions;
- Often, changes in groundwater quality and quantity can be observed in monitoring wells before changes occur in stream water quantity and quality, providing an "early-warning system," so that remediation activities can be initiated prior to impacts on surface waters and/or down-gradient groundwater aquifers.

Communication plan

Information on water quantity and quality should be communicated regularly to the public through a comprehensive communication plan. The data types displayed should combine all data collected as part of the monitoring plan, and available historical data. Locations of sampling sites should be linked to raw data as well as to graphs and other interpretive products that illustrate water quality and quantity patterns over time. The graphs should also compare the measured concentrations of analytes relative to standards discussed below.

FIGURE 4 A traditional agrarian landscape—the source of subsistence livelihoods for many communities. (Photo by Anthony Bebbington)

Monitoring activities and tools

Climate

Weather affects all mining operations. Recommended instrumentation includes: 1) continuous precipitation collector (Belfort is a popular supplier) for total rainfall; 2) tipping bucket precipitation collector for storm magnitude; 3) shielded air temperature; 4) shielded relative humidity; 5) wind speed; 6) wind direction. Instruments should sample approximately every second and means recorded and reported at 10 or 15-minute intervals.

Air quality

Mining activities can perturb air quality in the surrounding area for several reasons: removal of protective vegetative cover, disturbance by mining equipment, milling of ore into small-diameter particles that are easily transported by wind, generation of toxic metals, etc. A good manual for on-site requirements and methods is provided by

Any monitoring plan must have a formal, independent, external verification program.

the US National Atmospheric Deposition Program at http://nadp.sws.uiuc.edu/QA/.

Water quantity

The primary objective of a water quantity study is to quantify potential effects of mine operations and facilities on surface water flow and flow from springs. Discharge should be measured continuously at the most important sites. A less expensive method for continuous measurements of discharge uses pressure transducers that are placed on the stream bottom. In both methods, a stage–discharge relationship needs to be developed for the specific locations using manual measurements of flow. Infiltration rates to the subsurface are estimated by collecting soil cores and testing them to learn how the soils in the study area store water and how water moves through them. Soil cores should be collected periodically from the tailings pile and the same measurements conducted to understand how much water may be infiltrating the tailings pile and flowing over the surface of the tailings pile.

FIGURE 5 "Without water there is no life. Let's take care of it." Placard in Rio Blanco. (Photo by Mark Williams)

Water quality

The water quality investigation should be designed to determine whether mining activities have changed the quality of water in streams and canals that flow from the Rio Blanco mining area such that the water may be unsafe for domestic and agricultural (livestock and irrigation) uses or aquatic life. Questions about the safety of water use for drinking and cooking, skin contact, agricultural use, and aquatic habitat can only be answered by comparing the chemicals (analytes) in sampled water to water quality standards. We recommend standards established by the World Health Organization (WHO), the US Environmental Protection Agency (EPA), and Environment Canada because they incorporate toxicological data on risks to human health and biota, and they are set to be protective of human health and the health of other biota.

Water quality should be measured at all locations where water quantity is measured. Water quality should be measured daily to weekly in all surface waters that drain the mine site, including the streams that drain the valleys where the tailings and waste rock will be stored, any surface flow from processing facilities, water treatment facilities (eg pumping of groundwater from the open pit, sewage plant), and the Rio Blanco river below the mine site. These distributed sites should number at least 40. It is essential to sample springs down-gradient from the mine site. There are numerous chemicals (analytes) that water can be sampled for; see the Niwot Ridge LTER site for examples (http://culter.colorado.edu/NWT/).

Groundwater

Mine facilities such as waste rock dumps and heap leach pads can reduce the amount of groundwater recharge and degrade water quality. Groundwater discharge is often an important contributor to stream flow, with the relative portion of groundwater contribution to stream flow often changing seasonally. Monitoring of groundwater quantity and/or quality can be an indicator of possible future conditions in surface waters and springs.

Recommendation

It is important to install groundwater monitoring wells and to monitor water levels and water quality within the wells as an indicator of possible future conditions of water quantity and quality down-gradient. Monitoring well sites for water quantity should be numerous enough and spatially distributed so as to calculate groundwater velocities and discharge to down-gradient areas. Only a subset of wells need to be sampled for water quality; analytes should be the same as for surface waters.

Mine closure plan

Mines remain a source of pollution and contamination for decades to centuries after closure. A mine closure plan is critical to ensure that acceptable water quality and quantity are maintained into the foreseeable future. Closure plans developed by Rio Blanco should define objectives, procedures, and long-term, post-mining measures necessary to maintain acceptable water quality and quantity and address long-term impacts from tailings piles, waste rock dumps, and open pits. Often, acidic lakes with high amounts of toxic metals form as abandoned pits fill with water. Mine closure plans should be developed and made public before the initiation of the mine.

Conclusion

Tensions continue to simmer in Rio Blanco (Figure 5). Environmentalists and local leaders have been accused of terrorism, while Monterrico has been purchased by a Chinese consortium that has suggested the mine will be larger than initially planned. Final plans for water monitoring and mine closure will only become clear in environmental impact studies that have not yet been made public. Conflicts run far too deep for a monitoring plan to resolve them—but as long as populations continue to believe their water is threatened, these conflicts will continue.

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http://snobear.colorado.edu/Markw/mark.html