SATELLITE IMAGERY COMBATS ECO-DESTRUCTIVE ACTIVITY IN THE AMAZON

GOLD MINING IN PERU

The Madre de Dios (MDD) region of southern Peru is one of the most biodiverse regions in the world, home to thousands of endemic flora and fauna. Like most wild places, MDD is facing tremendous environmental degradation, primarily in the form of artisanal gold mining. This phenomenon has had seemingly irreversible impacts on the department's water quality, forest carbon stores, biodiversity, and human health.[1] All of these complications emerge from the unregulated excavation of soil along waterways, removal of trees, and heavy use of mercury to extract gold.[2]

The 2008 global recession, along with the construction of the Interoceanic Highway through the Madre de Dios, has accelerated gold mining in recent years, providing miners with more access to forested areas. Due to

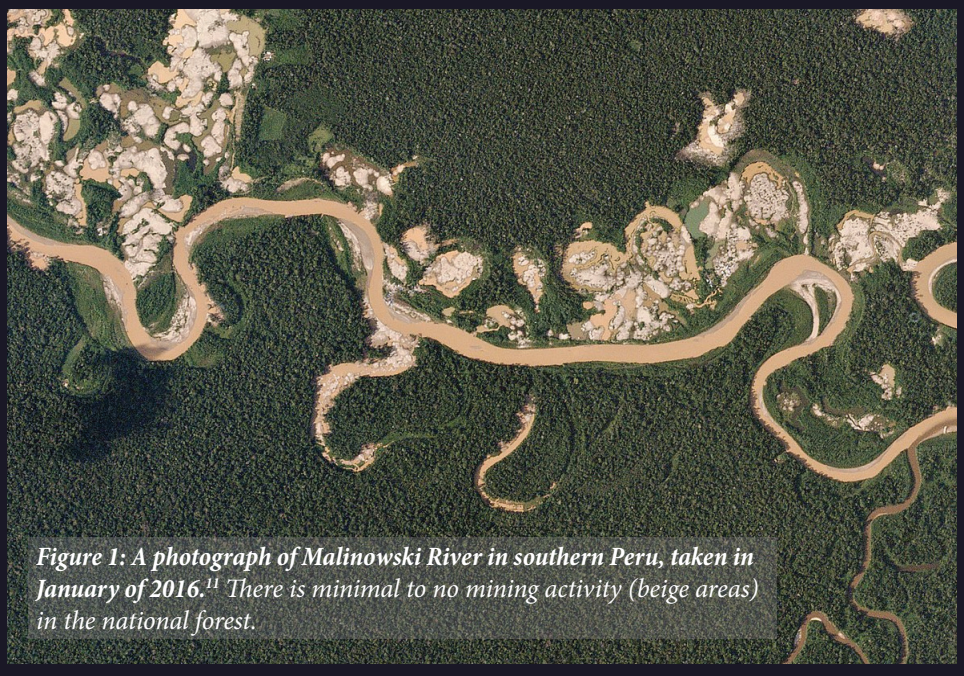

Figure 1: A photograph of Malinowski River in southern Peru, taken in January of 2016.[11] *There is minimal to no mining activity (beige areas) in the national forest.*

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increasing economic demands for gold, miners increased their pace in MDD, and the total estimated gold mining area skyrocketed by 40% between 2012 and 2016.[3]

Although Peru adopted legislation in 2012 to prevent and enforce a ban on illegal gold mining, one of the biggest challenges for the government has been monitoring and detecting small-scale attempts to mine gold, especially within heavily forested areas. In order to combat the small-scale mining, scientists, environmental organizations, and the Peruvian government began using detailed software forest monitoring technologies like CLASlite. These softwares automatically convert satellite images into a raw format that makes it easier for scientists to differentiate between high-impact deforestation zones and untouched areas.[3,4] While CLASlite can pinpoint where miners are operating, raids on mining camps are often unsuccessful due to the ease of mobility of the illegal mining equipment and the sheer number of miners willing to replace those who are arrested. Regardless, CLASlite has helped scientists paint a more accurate picture of the destruction in the Peruvian Amazon. According to research conducted by CLASlite in southern Peru in 2018, previous estimates for gold-mining related damage were off by over 30%.[3,4] It is clear that the technology to monitor gold-mining is operational, but in order to halt the industry altogether, more money needs to be allocated for police enforcement. The Peruvian government also needs to make the punishment for such activity more severe. This approach has had a proven track-record of success, especially in Brazil.

Figure 2: Another photo of the same Malinowski River, this time taken in January of 2017.[12] *The photo demonstrates the pace and damage of gold mining. Mining activity infiltrated even the Tambopata National Reserve.*

PREVENTIVE MEASURES

In order to mitigate the environmental issues within the Amazon, local governments need to find ways to prevent further damage to these ecosystems. A symptom that illegal deforestation, cattle ranching, and gold mining all have in common is the severe loss of trees in the impacted regions.[5] Tracking these illegal activities is a matter of identifying the regions where trees are at risk.

The main preventative measure against deforestation is the strict enforcement of environmental legislation, specifically using technology as a tool to detect and identify forestry exploitation in real time. Adopting this methodology, the Brazilian government successfully managed to decrease deforestation by 70% between 2005 and 2013.[6,7] The sharp decline was a result of a government initiative started in 2004 known as the Plan for the Protection and Control of Deforestation in the Amazon (PPCDAm) which utilizes Real Time System for Detection of Deforestation, DETER, a satellite deforestation imaging technology. The government began monitoring the rainforest in real-time, and whenever an area was identified as an active deforestation zone, Brazilian environmental police from the Brazilian Institute for the Environmental and Renewable Natural Resources, IBAMA, would raid the region, fining and arresting the responsible perpetrators. Researchers studying Brazil's enforcement techniques noted that an increased number of law enforcement personnel with better training helped curb significant illegal activity and concluded that the increased number of fines issued decreased the amount of deforestation in the following year.[6,8] The fines create a disincentive for those planning to continue to exploit these resources.[9]

Another unique problem attributed to the prevention of ecosystem damage is that all deforestation is not the same. In the late 1990s and early 2000s, farmers in Brazil clear-cut large portions of land, yet with the increase in government crackdown, landowners realized that a better way to clear forest was to do so in smaller plots. As long as the area cleared is less than 25 hectares (or the equivalent of about 20 soccer fields), DETER and other satellite technologies cannot detect changes in forest size. In addition, different states in Brazil tend to distribute land in different ways, therefore changing how landowners clear property.[10] For example, in the state of Mato Grosso, the average property size is significantly larger so deforestation is easy to detect. On the other hand, Para state has smaller, harder-to-detect properties, which requires more accurate technologies to monitor. As a result of these differences between states and deforestation techniques, policymakers must modify their strategies between regions to be most effective.

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Figure 3 (right): A dredging operation in the MDD. *The boat collects and rinses rock in search of gold, then dumps it back into the river. Photo courtesy of Dr. Donald C. Taphorn.*

Figure 4: Destruction of riparian forest can be seen as the miners gouge out the shoreline of Mazaruni River. *Photo courtesy of Dr. Donald C. Taphorn.*

Gold mining in southern Peru continues to pose a major threat to the Tambopata National Reserve, one of the most biodiverse ecological regions globally. Major steps need to be taken to combat the damage. First, the Peruvian government must adopt more restrictive legislation to prevent deforestation and gold mining. In addition, larger penalties and heavier fines need to be assigned to those who break the laws. Second, the Peruvian government must allocate more funding towards hiring forestry police. Third, the current satellite imaging technology needs to be updated so that finer details in forest composition can be traced. Hope for these areas still remains—as long as nonprofits and governments work together to not only find a solution for forestry conservation or restoration, but also discover an economic incentive for the underprivileged workers.

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