Rapid Change and Development in Tropical Ecosystems due to Alluvial Gold Mining: A Multi-Sensor Fusion Approach to Quantify Impacts

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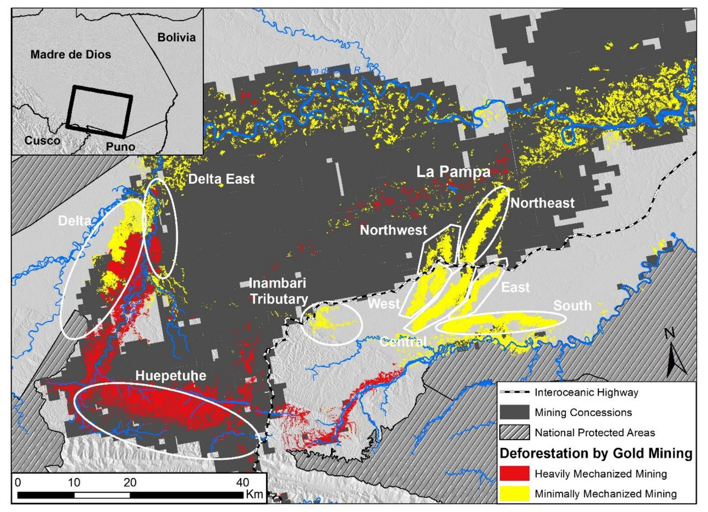
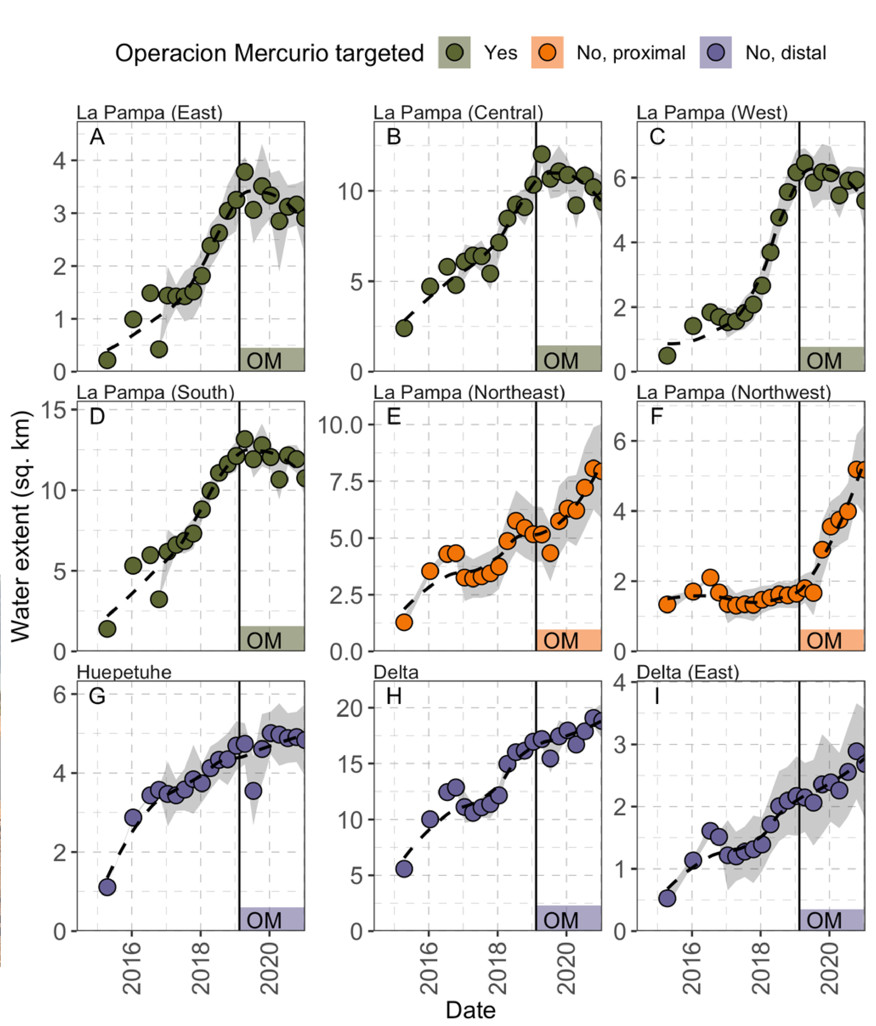
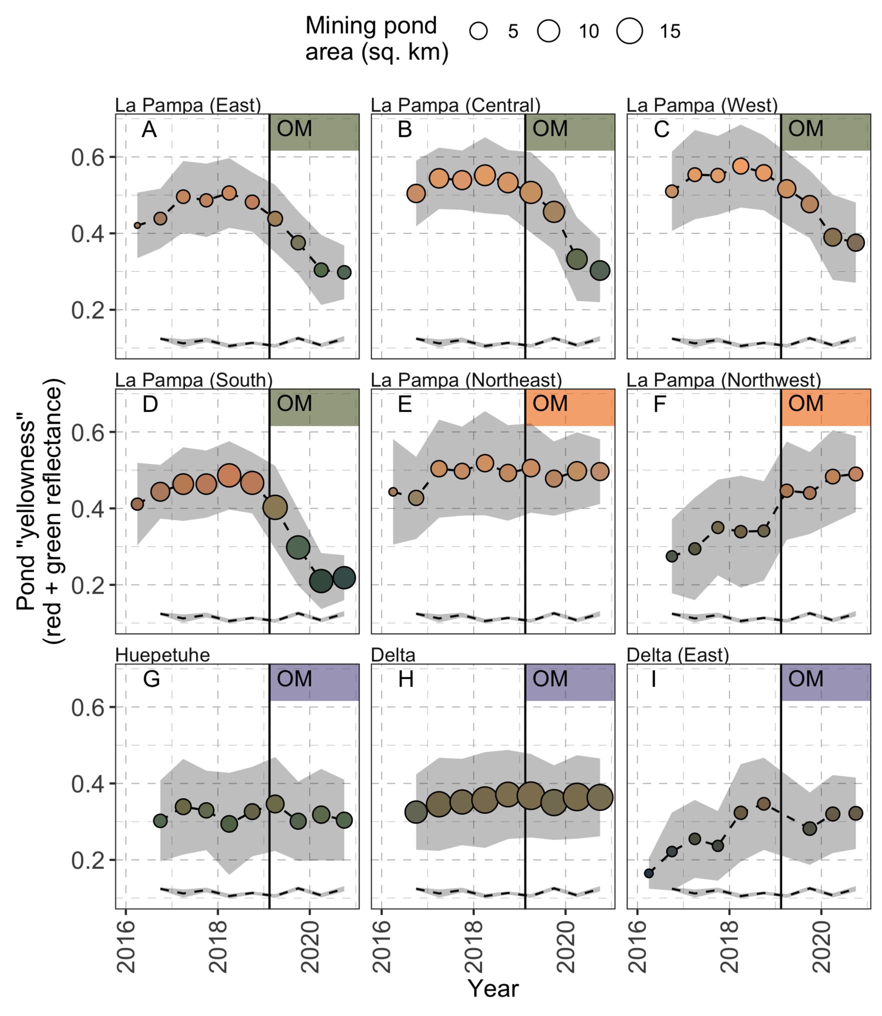
Peru's Operation Mercury successfully stifled mining in its targeted areas, but activity shifted northwards

Dethier et al. *In Review* A



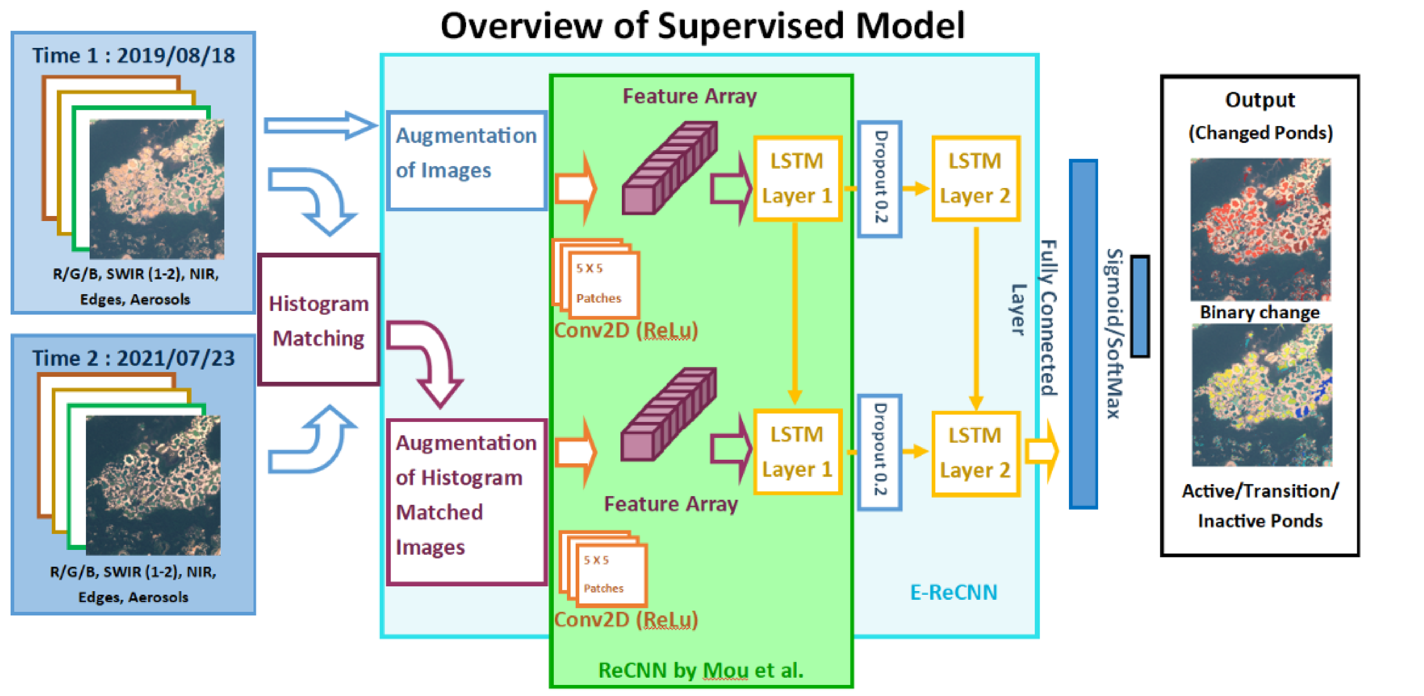




We examined 9 mining areas (*Left, top*) using both Sentinel-1 and Sentinel-2 to estimate change in mining pond extent and 'yellowness' before and after Operation Mercury (*Left, bottom*). Overall, pond extent changed from increasing by 33-90% per year before the intervention, to decreasing 4-5% per year afterwards (*center*). Between 70-90% of all ponds were abandoned in the targeted mining zones (*right*). However, we found that mining activity in nearby areas north of the intervention zone increased, with pond area increasing by 42-83% and deforestation totaling 3-5 km^2 per year.

Deep Learning allows for the identification and tracking of individual mining ponds and activity

Camalan et al. 2022, *Remote Sensing*



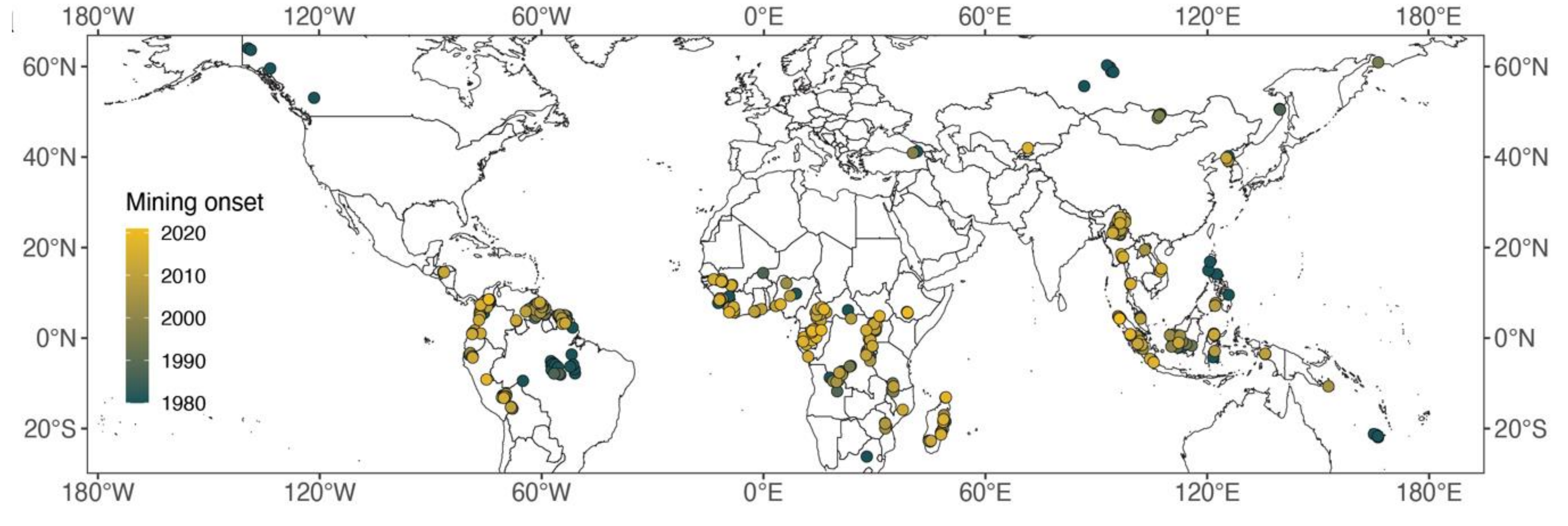
We developed E-ReCNN, which combines convolutional and recurrent neural networks into a singular network. This is a supervised deep learning approach that identifies features (ponds) and keeps track of each pond's status (actively mined, inactive, or in a state of transition between active and inactive).

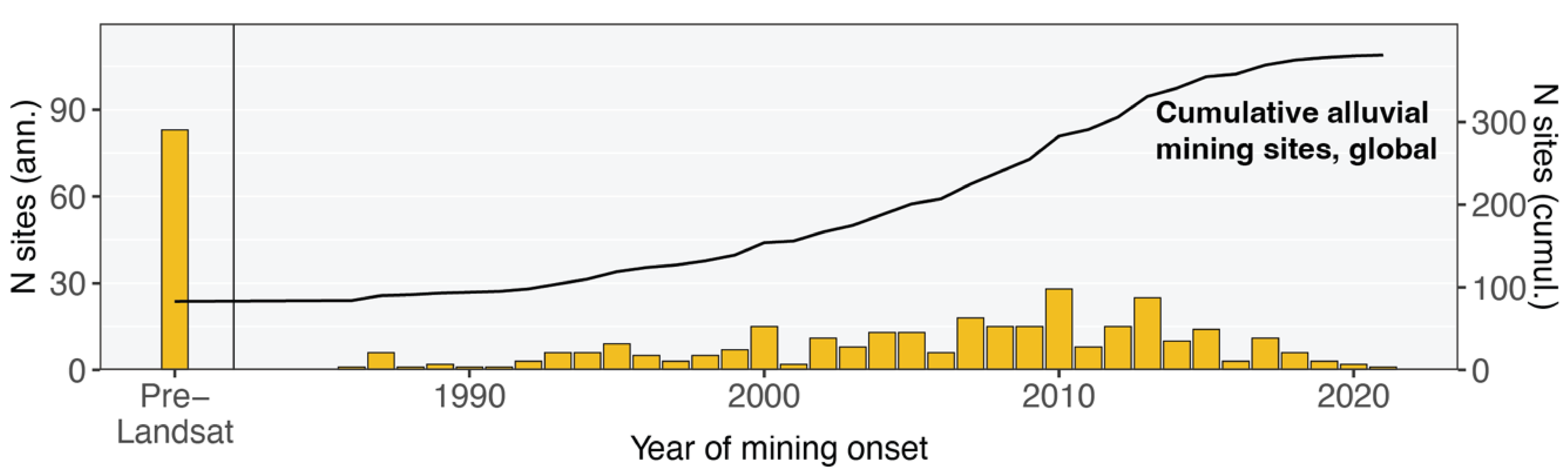
Supervised(E-ReCNN) methods allowed for the tracking of individual ponds in our study area with high accuracy (Kappa: 0.92 (± 0.04), F1: 0.88 (± 0.05) (*right*). This method also translated to mining areas in other countries (Venezuela, Indonesia) with similar success (Kappa: 0.90 (± 0.03), F1: 0.77 (± 0.04).

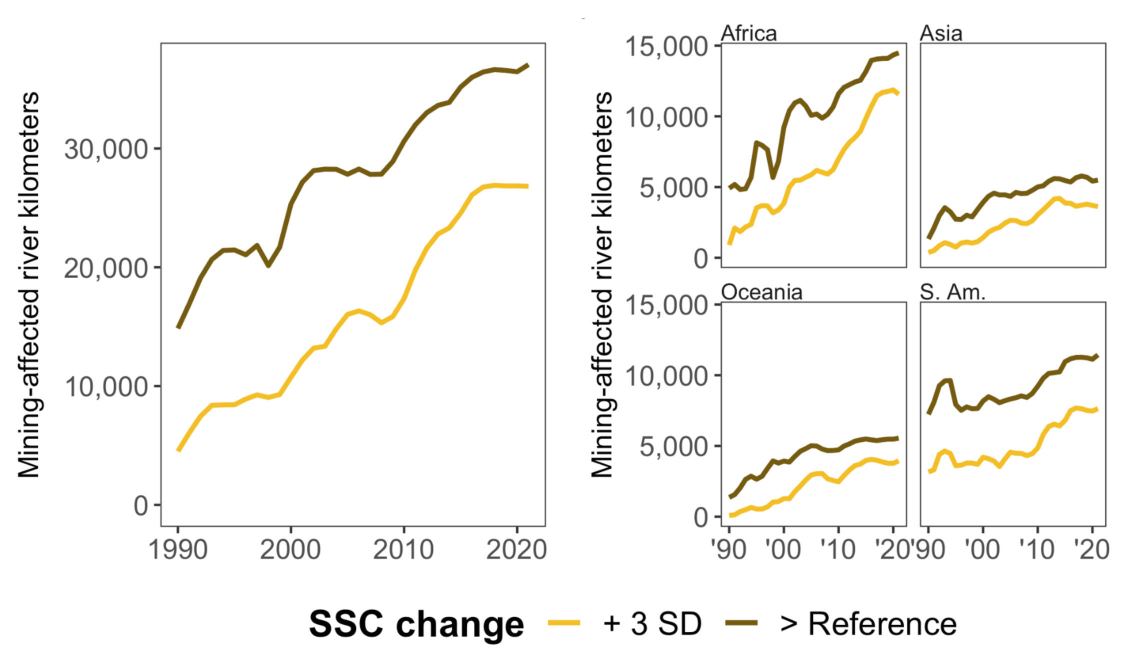
Region	Kappa Coef.	Jaccard Coef.	F1 Score	F1- No Change	F1- Decrease	F1- Increase	F1- Water Existence
La Pampa - R4	0.945	0.916	0.954	0.993	0.969	0.896	0.956

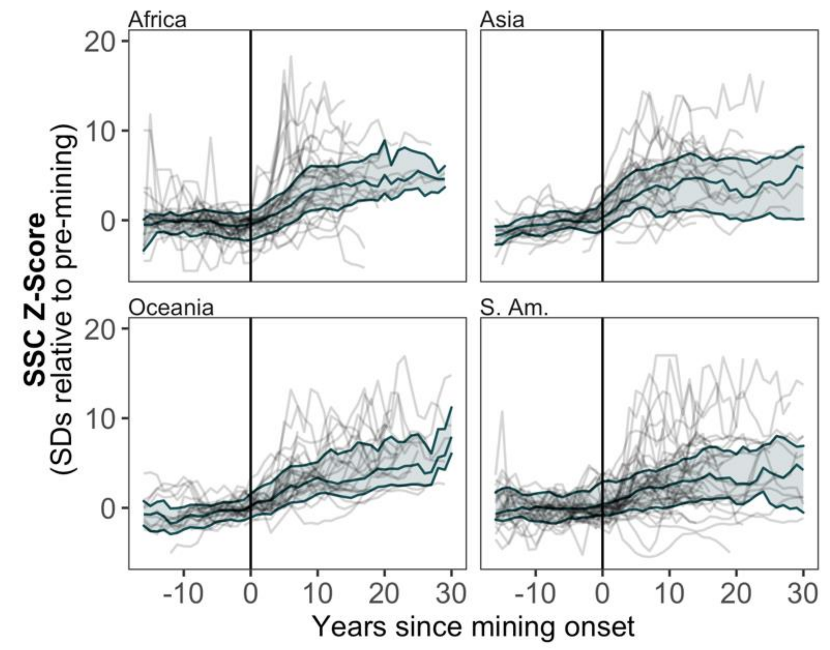
Alluvial Gold Mining is an unrecognized major threat to tropical rivers across the planet

Dethier et al. *In Review* B









Using data from the Landsat 5 and 7 ETM+ records, we assessed the impact of alluvial gold mining across the planet. We identified 381 mining areas across 49 countries (*Top Left*), affecting 173 rivers, with mining beginning after 2006 in 45% of all sites (*Bottom Left*). We estimate over 35,000 river km in which SSC has been altered by mining, with over 21,000 km having SSC more than double their pre-mining average (*Above Left*). Across all continents, SSCs increase by several SDs relative to pre-mining levels following mining offset (*Above Right*). Our results provide a timeline for river impacts at a country-wide resolution (*Right*).