Produced for “Forest Monitoring and Carbon Stock Estimation with Multi-Source Remote Sensing in the Context of Climate Change”

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What is RAMI?

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Introduction → RAMI → what RAMI does
Hello everyone ,

My name is Micky Maganini, and I work for SERVIR, a U.S. Government organization and partner of ITC. Today I am going to introduce you to a web-based tool called RAMI that was developed by SERVIR. RAMI is a change detection algorithm used by SERVIR to monitor deforestation in the Amazon due to illegal gold mining.

Context

Before we learn more about RAMI, I want to provide some context about What SERVIR is.

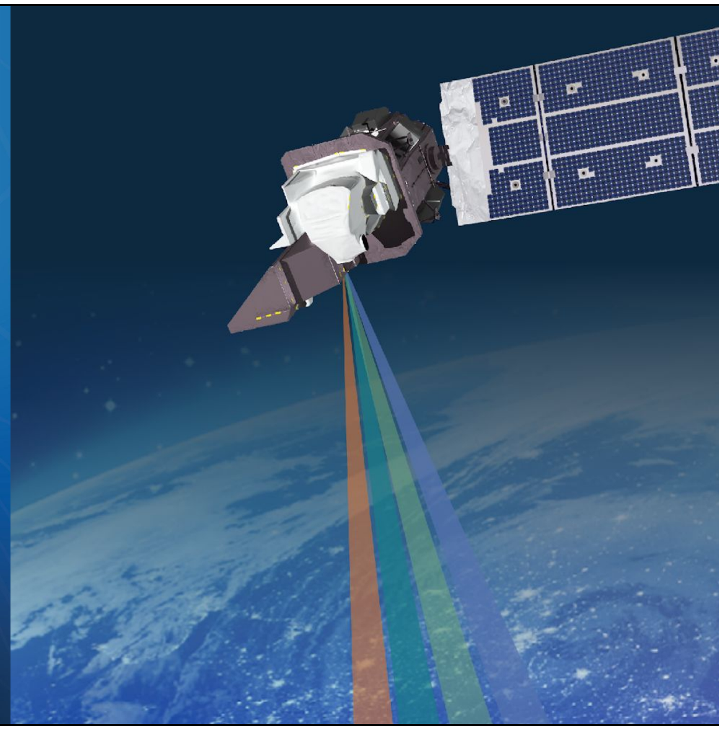
joint program → hubs

SERVIR is a joint program between NASA and the US Agency for International Development. We develop solutions to address environmental challenges using earth observation data. We work with organizations around the world in five regional hubs to create these solutions.

SERVIR network → ITC & SERVIR

Beyond our regional hub institutions, we partner with organizations in the private sector, intergovernmental organizations, NGOs, and research institutions like ITC. ITC and SERVIR have partnered with each other since 2018 as both institutions apply earth observations to sustainable development on a global scale.

What is RAMI?



RAMI Background

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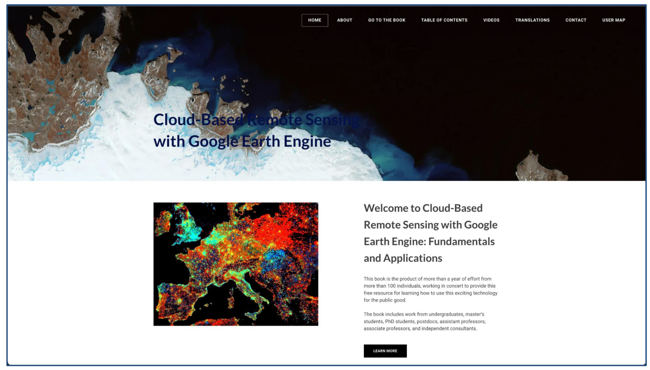
RAMI (Radar Mining and Monitoring Tool) is…

- Open source
- Documented
- Cloud-based
- Customizable



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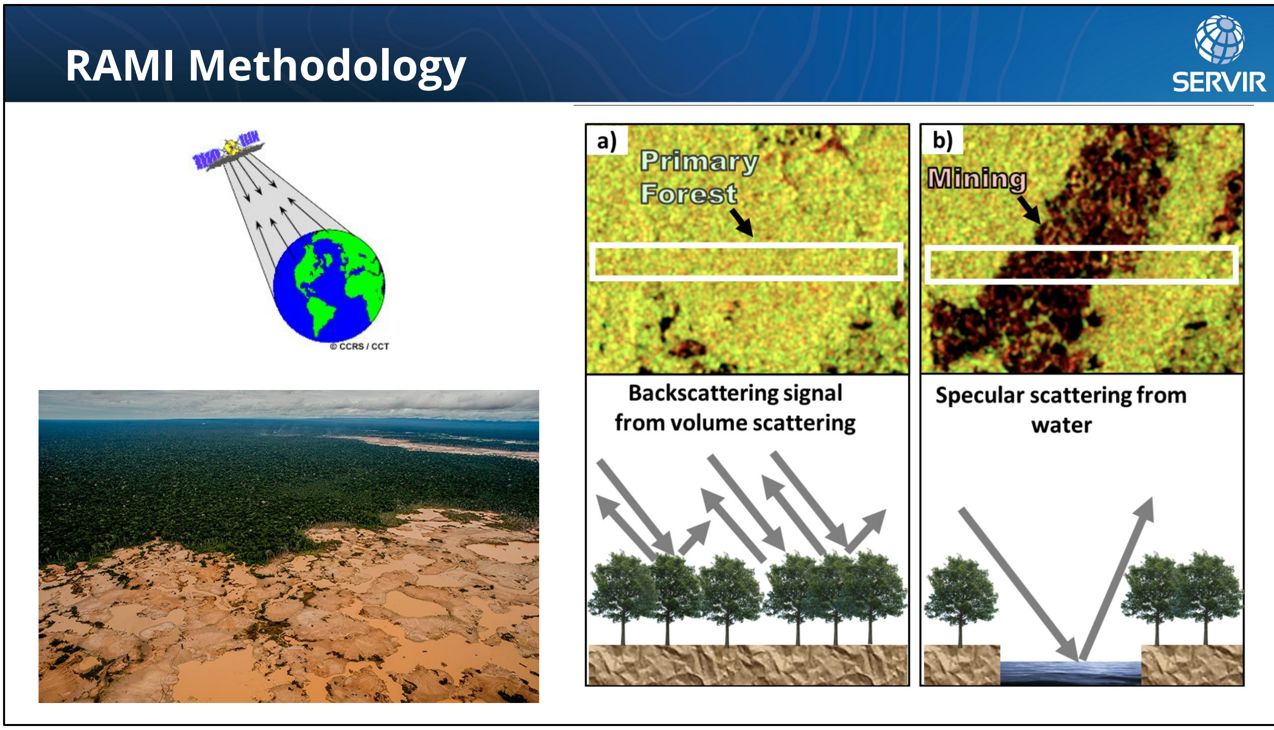
RAMI – which stands for the Radar Mining Monitoring Tool, is a change detection algorithm implemented in Google Earth Engine. RAMI consists of a web portal where our end users can see areas that the tool is predicting have undergone change due to deforestation, as well as the code that it runs on. RAMI was co-developed by Conservacion Amazonica, Bosques en tus manos, and SERVIR-Amazonia, and delivers deforestation alerts to Peru's Ministry of the environment. The code is open source and is documented, allowing anyone to use the code for a separate ecological problem and/or geographic region



So what's the theory behind why we would be able to detect areas where alluvial gold mining is occurring using SAR signals?

Well as you may know, SAR is an active sensor, meaning that it both transmits and receives an electromagnetic wave or signal. As shown by the graphic in the upper left, the signal bounces off the Earth's surface, and is returned to the sensor. The strength of this return signal, often called the backscatter, depends on the relative roughness of the imaged surface, among other factors. Because alluvial gold mining affects the surface properties, we are able to detect this change via a SAR signal.

The process of alluvial gold mining involves the removal of forest cover and topsoil, excavation, and the use of water to extract the gold from the loose sediment. The image on the lower left shows how the normal landscape looks compared to a mining pit.

So while the backscattering signal from forested areas are strong due to volume scattering, the backscattering signal from areas where gold mining is occurring is weak due to specular scattering of the water. This is shown by the schematic on the right side, where the VV band of the SAR data is assigned to the red and blue channel, and the VH band is assigned to the green channel. Areas that appear yellow here are showing a strong backscatter, whereas those darker areas are showing a weak backscatter. We can see below why that is.

RAMI Workflow

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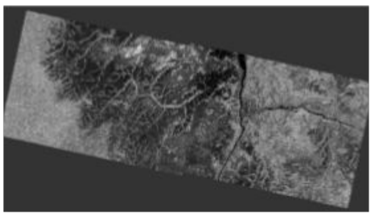
Step 1: Create a Time Series of SAR Images → Step 2: Apply Omnibus Q-test Algorithm → Step 3: Post-processing



$$\ln Q = n\left(pk \ln k + \sum_{i=1}^{k} \ln |X_i| - k \ln \left| \sum_{i=1}^{k} X_i \right| \right),$$

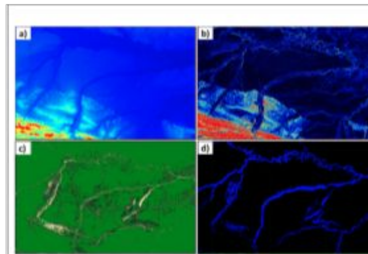


Fig. A1.8.9 Layers used to filter false positives alerts: a) SRTM elevation, red color shows areas over 1000 meters above sea level; b) SRTM slope, red color shows areas with slope over 15 degrees; c) Hansen Global Forest Change, green color shows forested areas updated to 2020; d) JRC Yearly Water Classification History, blue color shows the maximum extent of water surface detected from 1984 to 2020.

Here we can see the general workflow of RAMI. Our first step is to pre-process the SAR data (specifically masking SAR images acquired at an incidence angle less than 31 or greater than 45 degrees), then creating a time series of mosaic of SAR images for a given time, region, and orbit pass. In Step 2, we apply the omnibus Q-test algorithm to our time series to generate change alerts. In Step 3 we will filter and eliminate potential false positive alerts coming from other activities with the same temporal pattern as the mining activity (e.g. natural forest loss by river expansion or water over bare soil during the rainy season). We do this by filtering out alerts that occur at an elevation above 1000 meters, in areas with a slope greater than 15 degrees, areas where there is not forest, and areas that were identified as water bodies. The elevation postprocessing step is taken due to the fact that in the Madre De Dios region, mining occurs in lowland areas. The slope step is taken because radiometric terrain correction is not applied to our SAR data, so steep regions show distortions. The forest step is employed using the Hansen Global Forest Change dataset, and the water step is taken via the JRC Global Surface Water Dataset. The water step is to remove false alerts that occur due to natural forest loss due to changes in river morphology.

RAMI Use Cases

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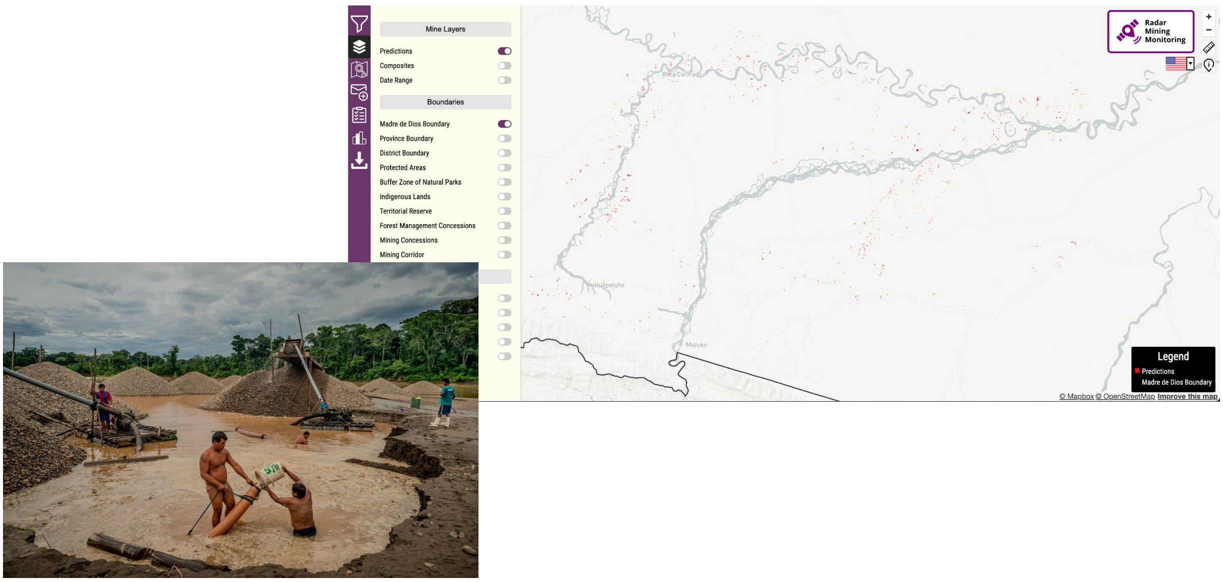

Why should you use RAMI as opposed to other SAR change detection tools? Because RAMI is used operationally by our colleagues in SERVIR Amazonia to combat illegal deforestation in real time. And it's working to stop a real problem which affects real people. On the Right side you can see the web interface where our end users can see real time deforestation alerts by RAMI. This web interface is open source and is online and can be accessed. So you may be asking, why was RAMI created in the first place? Why is gold mining an issue that we should care about?

According to Caballero et al 2018, illegal gold mining in the Amazon has led to the deforestation of about 1,000 km^2 of rainforest, affecting protected areas, indigenous communities, and sustainable management areas.

World Resources Institute found that 6% of total indigenous land in the Amazon (14.3 mil ha) directly overlaps with mining concessions or illegal mining activities. These populations are affected due to the use of mercury to extract gold from the soil, which then enters the rivers and bioaccumulates up the food chain via fish. A study by Basu et al 2018 studied 46 indigenous populations in the Amazon and found mercury levels 7.5 times higher than the background levels in the general population.

Aside from the disastrous health impacts, the removal of the overlying forest cover contributes to carbon emissions. A study by Csillik 2019 found that in 2017 alone, deforestation in just the Madre de Dios region of the Peruvian amazon caused the equivalent of 1 million tons of carbon to be released, equivalent to the average carbon emissions of 250,000 cars per year.

RAMI is currently used only over the Madre de Dios region, and has a web app that our end users can use to identify areas where deforestation may be occurring in real time.

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Sources:

Development Team: https://sams.servirglobal.net/detail/10

Authorship Team:
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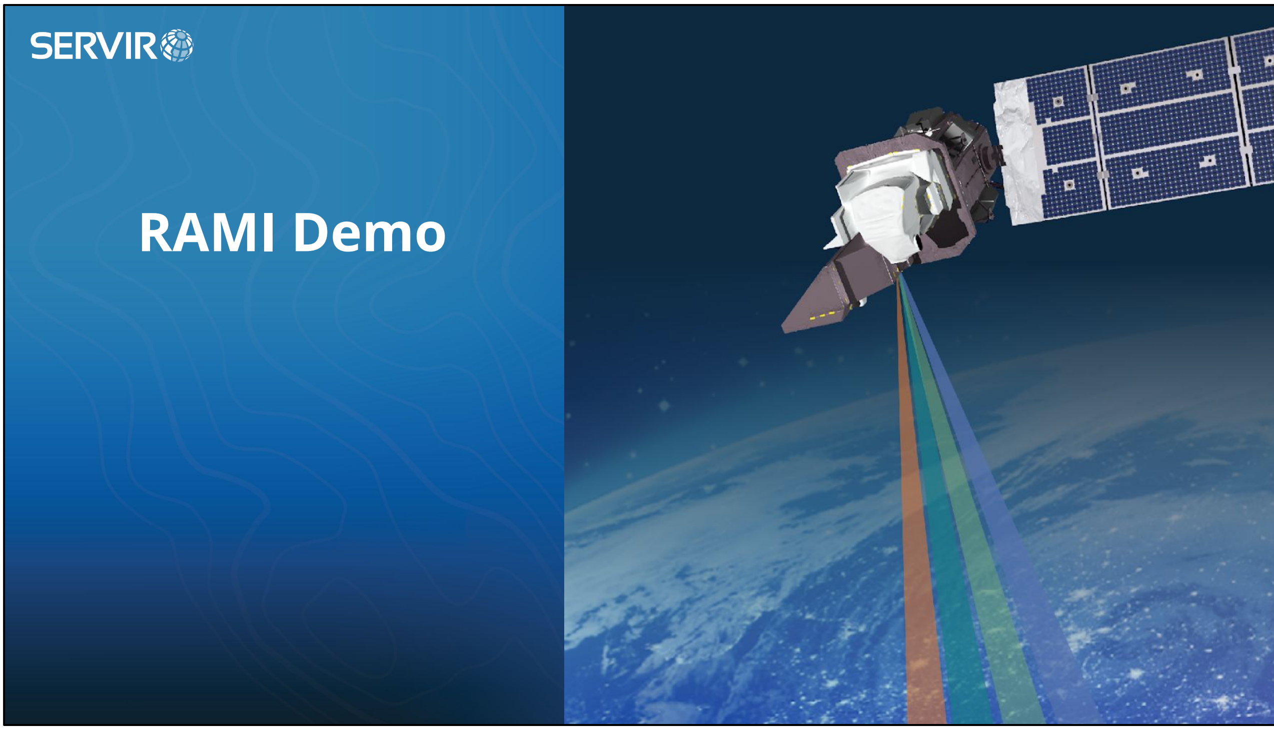

RAMI Demo

So now let’s look at how RAMI works in action


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