



Center for Climate Crime Analysis

*Documenting environmental crimes
through remote sensing*

Overview

- About CCCA
 - What is CCCA
 - CCCA's approach
 - CCCA's projects
- Cerro de Pasco example
 - Partners
 - Background
 - Evidence
 - Use of remote sensing

What is CCCA

- non-profit organization
- prosecutors and law enforcement professionals
- designed to support and scale up judicial action worldwide at the national and international level against environmental destruction or other illegal activities that contribute to climate change

CCCA's approach

- CCCA
 - directs and coordinates information collection of others
 - bridges the gap between those with access to information or expertise and law enforcement authorities and advocacy organisations
- Law Enforcement Support Model
 - Create case hypothesis and collection plan
 - Identify and mobilize information collectors
 - Analyse information
 - Build case files and provide them to competent authorities for further investigation and prosecution or other organisations for advocacy and legal action

CCCA's projects

- Forest crimes project: facilitating actions against drivers of deforestation on the “demand side” – hindering trade in commodities that drive illegal deforestation
 - Deforestation in the Amazon
 - Illegal logging – commercial exploitation
 - Cattle industry
 - Satellite imagery to control origin – tracing supply chain
 - IMAZON: Exploitation of concessions – density, protected areas
 - Signs of illegal logging (e.g., patios, infrastructure)
 - AMAZONIA PROTEGE
- Fossil fuels and mining project: Cerro de Pasco example



Cerro de Pasco



Background

- Peruvian Andes – 4.380 meters
- Capital of Pasco Region ~70,000 inhabitants
- Cerro de Pasco – self-proclaimed “mining capital of Peru”
- Mining exploitation since pre-colonial times
- 20th century: copper, lead, zinc, silver, bismuth and gold
 - North American Cerro de Pasco Investment Company – Cerro de Pasco Cooper Corporation (1915-1974) – open pit mining since 1956
 - State-owned Centromin 1974-1999 (“biggest mining complex and one of the biggest in Latin America” at the time of expropriation)
 - **Volcan 1999- present (Glencore since Nov. 2017)** – lead and zinc, doré
- Population heavily contaminated by heavy metals

Location of Cerro de Pasco

The city of Cerro de Pasco with its 70,000 inhabitants is the capital of the Pasco region on the high plateau of central Peru. At 4,330 meters (14,210 ft) elevation, it is one of the highest cities in the world.









EsSalud

2010
GRANDE

CCCA's approach in Cerro de Pasco

- Develop case hypothesis and information collection plan
 - Human contamination with heavy metals
 - Causes: ingestion of contaminated soil, water & food, inhalation of dust & air
 - Link between Volcan's operations and human contamination
- Identify and mobilise information collectors: partners
- Analyse information
- Build case file
- Trigger action

Partners

- Primary partner: **SOURCE INTERNATIONAL** —a non-profit organization of environmental scientists with over 10 years of experience in Cerro de Pasco
- Other organizations and experts have cooperated with CCCA in collecting and analysing information:
 - American Association for the Advancement of Science (“**AAAS**”) provided expertise in multiple scientific fields, such as remote sensing, satellite imagery analysis and toxicology
 - Cyber Environmental Law Enforcement (“**CybELE**”) provided Earth Observation services
 - Human Rights Program of the **University of Essex** and the Human Rights Center at the **University of California Berkeley School of Law** conducted open source investigations and analysis
 - A team of experts in forensic medicine conducted medical examinations of affected children;
 - the **Sant’Anna School of Advanced Studies** deployed scientific and legal experts in the field;
 - Centro de Cultura Popular **LABOR** provided local expertise, logistical support and access to local information and persons affected by the mine;
 - Architecture practice **SITU** produced a visual platform of the collected information

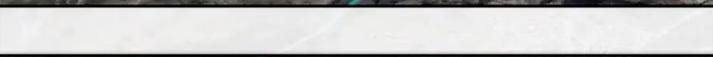
Evidence

- Open-source
 - Internet searches provided public (official) documents and reports, corporate documents and scientific studies
 - Information requests to Peruvian authorities: environmental sanctions, reports, underlying information used in decision making
 - Satellite imagery
- Documentary evidence provided by local partner
- Scientific analysis of the area and population
 - Soil studies
 - Water studies
 - Health studies
 - Atmospheric pollution dispersion model
 - Remote sensing



Background

Photogrammetric Reconstructions



Paragsha	Quiulacocho	Ayapoto
Mining Pit	Discharge Point	Football Field
Hospital	Top View	Extents



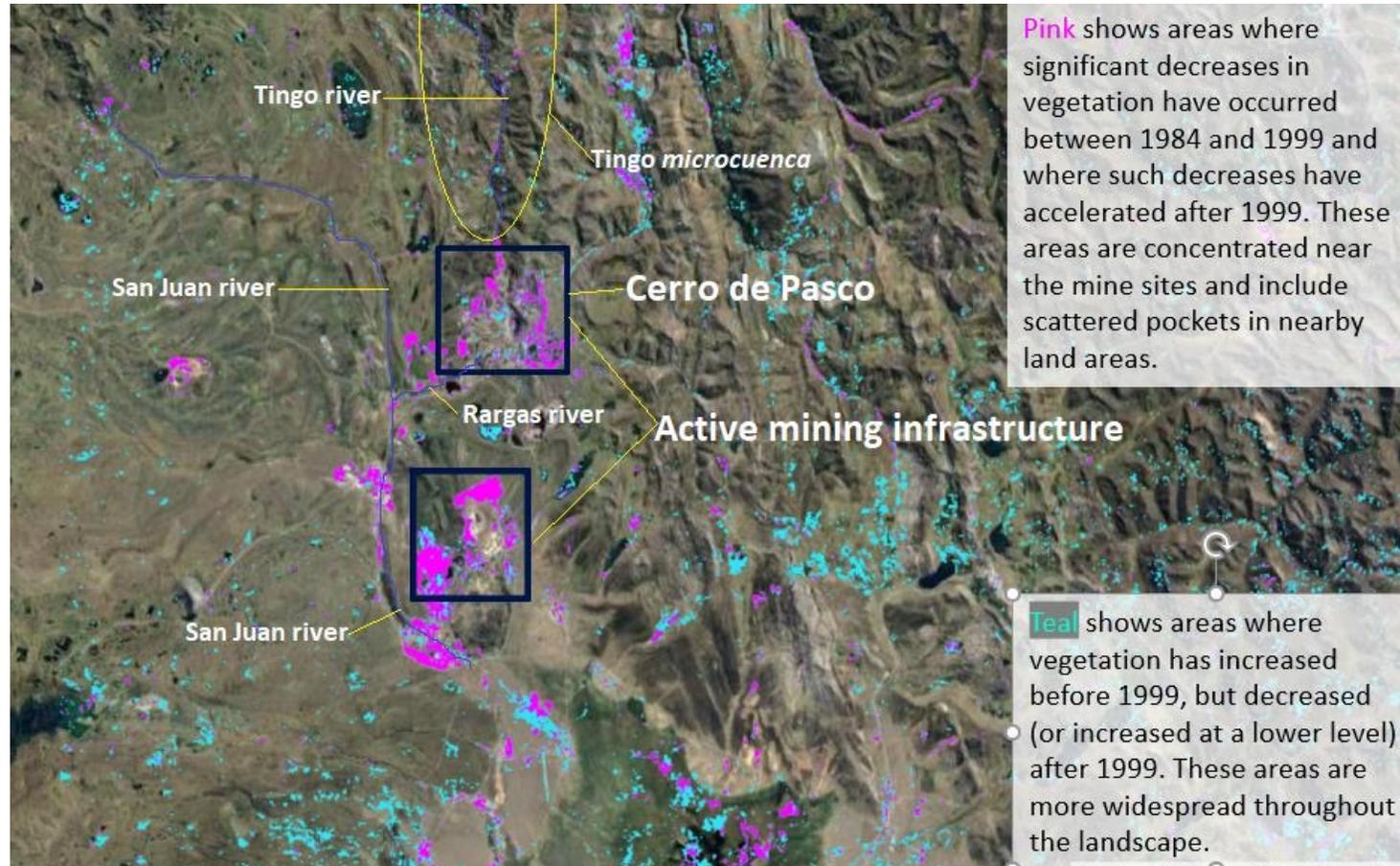
Use of remote sensing

- Changes in vegetation around Cerro de Pasco, 1984-2018
 - Nicholas Cuba
- Spectral detection of Pb contamination with ASTER and Sentinel-2 imagery
 - Chad Melton & David Hughes in collaboration with AAAS
- Lead, arsenic, water quality remote sensing
 - CyBELE

Changes in vegetation around Cerro de Pasco, 1984-2018

- **Purpose**: examine change in vegetation around Cerro de Pasco from 1984 until 2018
- **Methodology**: Normalized Difference Vegetation Index (NVDI), which approximates how “green” or photosynthetically productive vegetation is during an annual period
- **Conclusion**: significant decreases adjacent to, downstream from, and near Cerro de Pasco. These decreases have accelerated after 1999
- **How CCCA used info**: Volcan attributed responsibility for pollution to prior mining activities, this study links decrease in vegetation to the time of Volcan’s operations

Changes in vegetation around Cerro de Pasco, 1984-2018

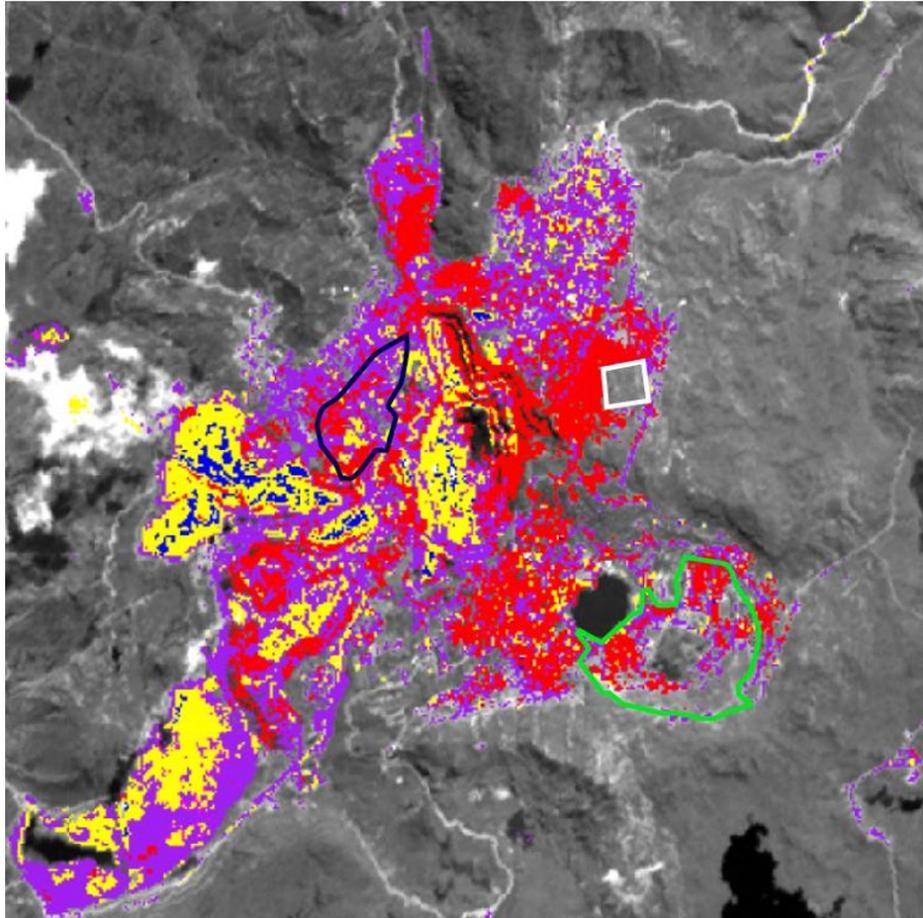


Spectral detection of Pb contamination with ASTER and Sentinel-2 imagery

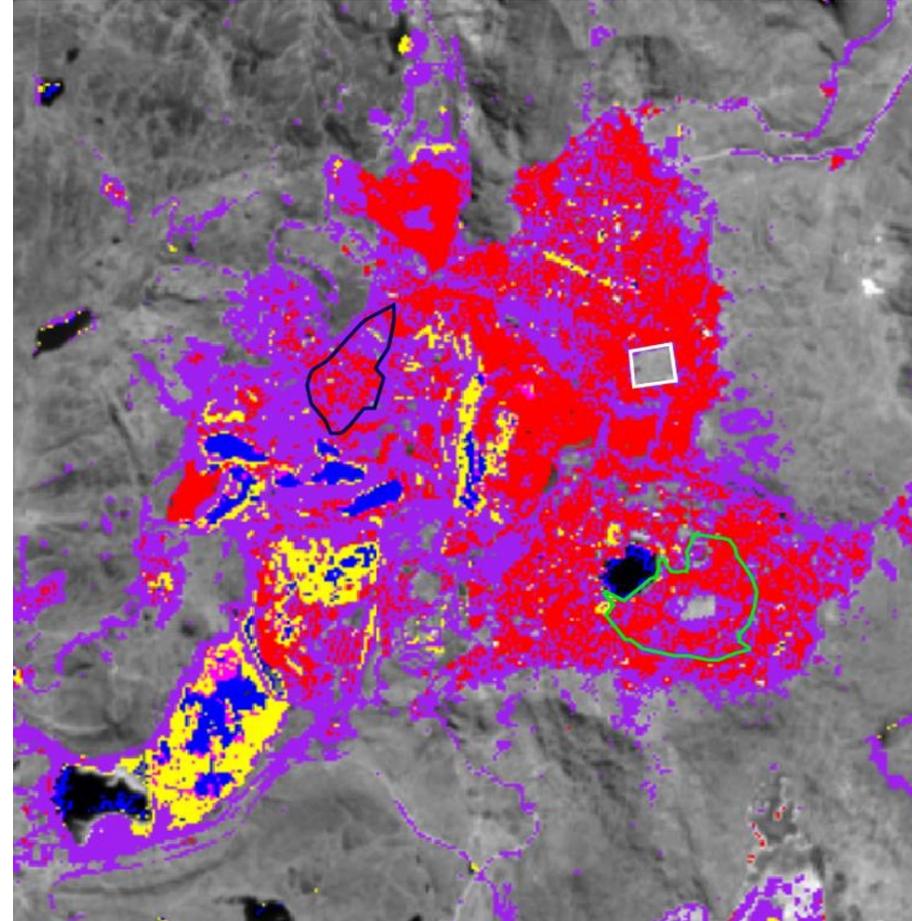
- **Purpose**: detect any possible changes in the distribution of lead (Pb) contamination in and around the city of Cerro de Pasco, Peru between 2001 and 2018 by means of reflectance spectroscopic mapping
- **Methodology**: This study conducted reflectance spectral analyses from imagery obtained from NASA's ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) satellite and the ESA's Sentinel-2 satellite.
- **Measured**: Anglesite ($\text{Pb}(\text{SO}_4)$), Cerrusite ($\text{Pb}(\text{CO}_3)$), Mimetite ($\text{Pb}_5(\text{AsO}_4)_3\text{Cl}$), Plumbojarosite ($\text{PbFe}^{3+}_6(\text{SO}_4)_4(\text{OH})_{12}$) and galena (PbS)

ROI: Cerro de Pasco Δ 97,70%

2001: 18,29%

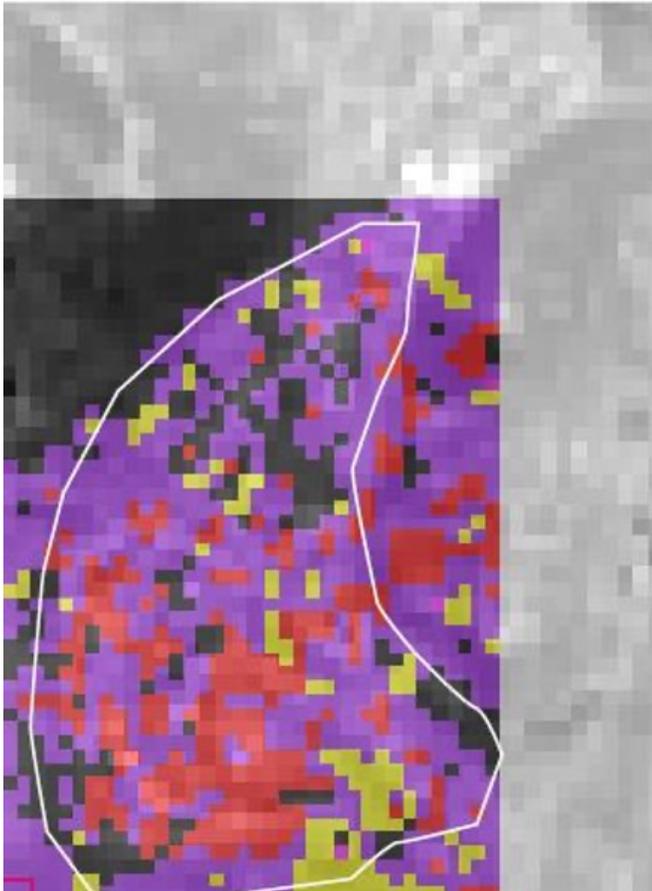


2018: 36,16%

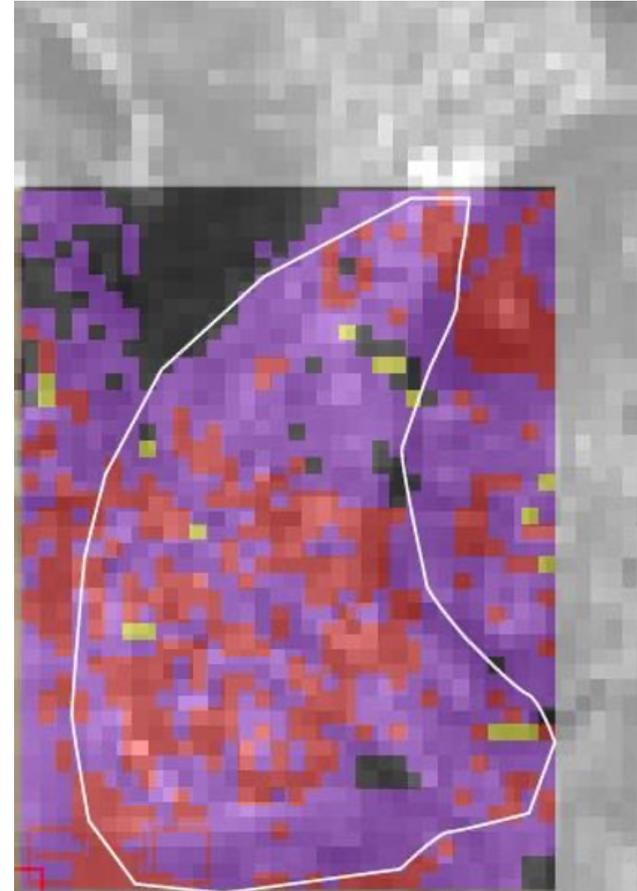


ROI: Paragsha Δ 15,50%

2001: 73,50%



2018: 84,89%



Spectral detection of Pb contamination with ASTER and Sentinel-2 imagery

- **Conclusions:**

- While in 2001 18,29% of the region of interest (ROI) contained lead bearing mineral species, in 2018, lead bearing minerals were detected in 36,16% of the ROI.
- In 2001, 73,50% of the area of Paragsha was classified as containing lead bearing minerals, while in 2018, it was 84,89%.
- A change in the distribution of mineral species within both ROIs can be observed as well.

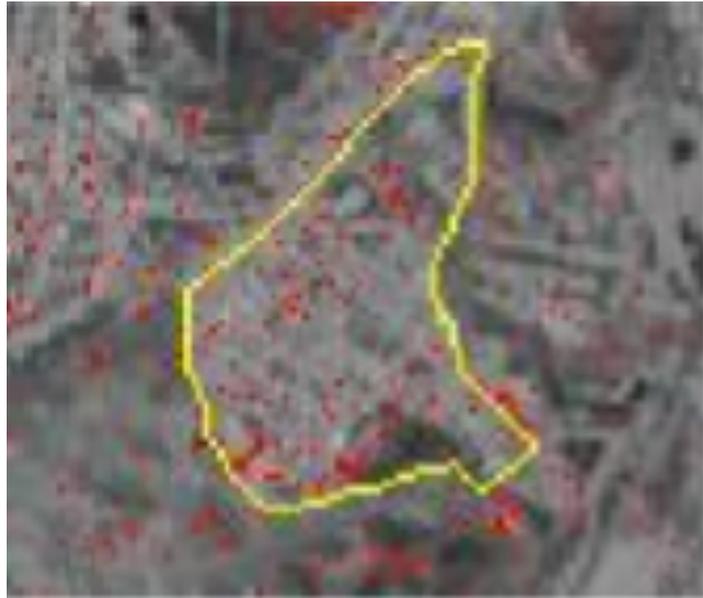
- **How CCCA has used it:** To show that the mining company has significantly contributed to contaminating Cerro de Pasco's soil by showing the increase in the areal expansion of the lead contamination between 2001 and 2018 (company acquired operations in 1999)

Cybele: Anglesite (Pb(SO₄)) Spectral detection with Sentinel-2 imagery

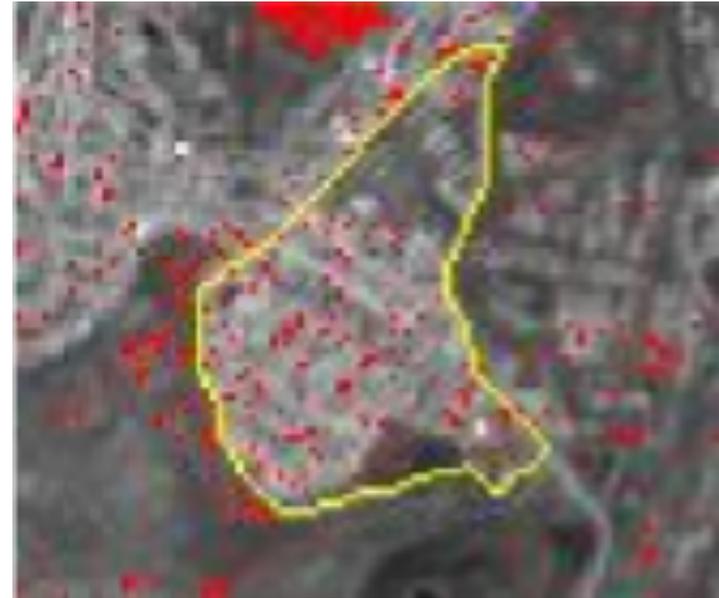
- **Purpose**: detect any possible changes in the distribution of lead (Pb) contamination in and around the city of Cerro de Pasco, Peru between 2001 and 2018 by means of reflectance spectroscopic mapping
- **Methodology**: comparison of spectral indexes of two ESA's Sentinel-2 images
- **Measured**: Anglesite (Pb(SO₄))

Cybele: Anglesite (Pb(SO₄)) Paragsha Δ
2700m²

26 April 2016: 10,200 m²



27 November 2018: 12,900 m²



Cybele: Anglesite (Pb(SO₄))

- **Conclusion**: In the area of Paragsha alone, there was an overall increase of 2.700² in the area covered with anglesite (despite some confined areas where the contamination decreased) between 2016 and 2018 .
- **How CCCA has used it**: separate remote sensing study conducted by CybELE further demonstrates that an increase of lead pollution in the soil of Cerro de Pasco, in particular in Paragsha, can also be observed for the more recent period. Shows the increase from a pre-Glencore majority image to during Glencore's majority.

CCCA's findings

- Many of Cerro de Pasco's inhabitants are severely contaminated with heavy metals, which severely impacts on their physical and mental health, especially the children of the neighbourhood of Paragsha.
- Contamination with heavy metals is caused primarily by the ingestion of contaminated soil, water and food and through inhalation or ingestion of contaminated dust.
- Since Volcan acquired the mine in 1999, it repeatedly introduced into the environment heavy metals in excess of maximum permissible levels established under Peruvian law → it significantly increased previous levels of contamination and significantly contributed to increasing levels of human heavy metal contamination from 1999 onwards
- Volcan is responsible for the environmental contamination in Cerro de Pasco and for the direct impact that this has on the physical and mental health of many people of Cerro de Pasco, and in particular of the children of Paragsha.



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Thank you