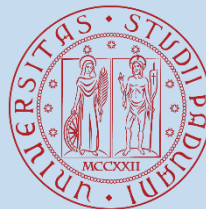




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INTERNATIONAL CONFERENCE ON CLIMATE JUSTICE – 27th October

Extreme Citizen Science for Unleakable and Unburnable Carbon in Amazon

Francesco Facchinelli

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The research group: Climate change, Territories, Diversity



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FRANCESCA PERONI



EDOARDO CRESCINI



GIUSEPPE DELLA FERA



FRANCESCO FACCHINELLI

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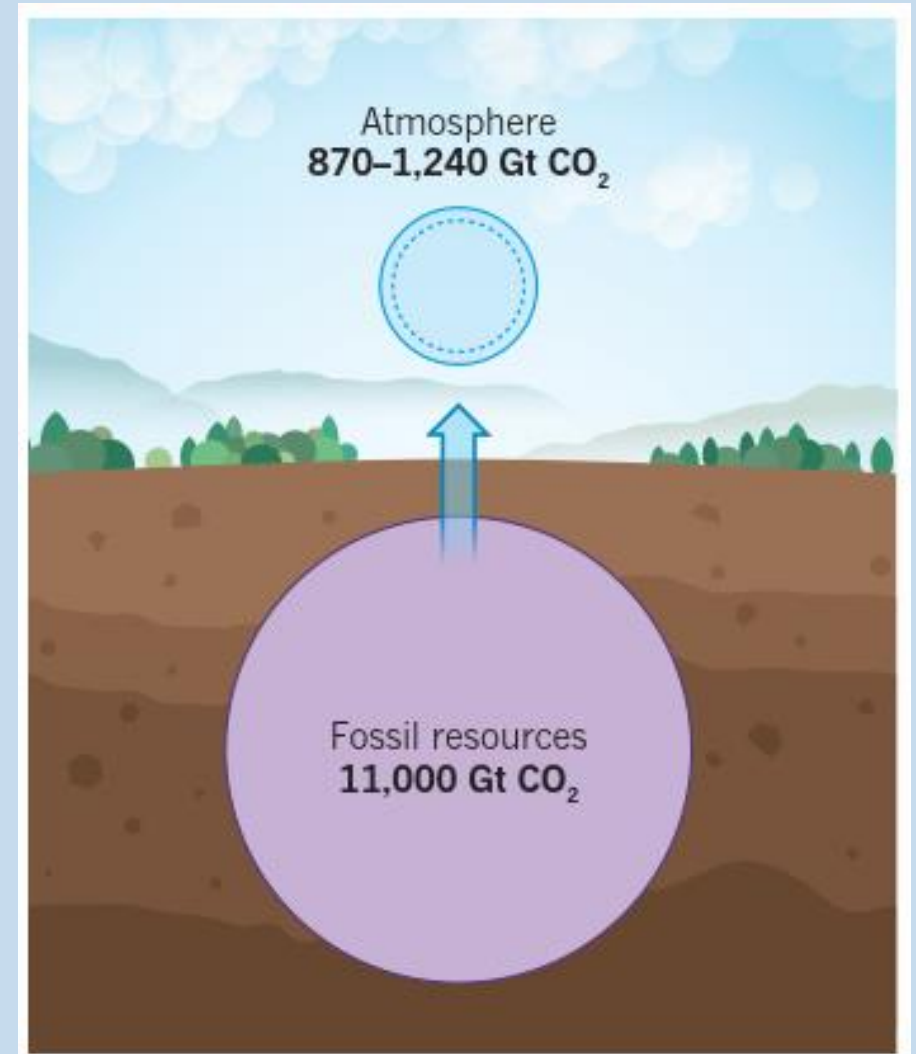


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Unburnable fossil fuel resources

Should remain “locked underground”:

- 35% of oil
- 52% of natural gas
- 88% of coal



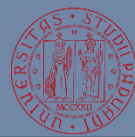
McGlade and Ekins, 2015, Nature

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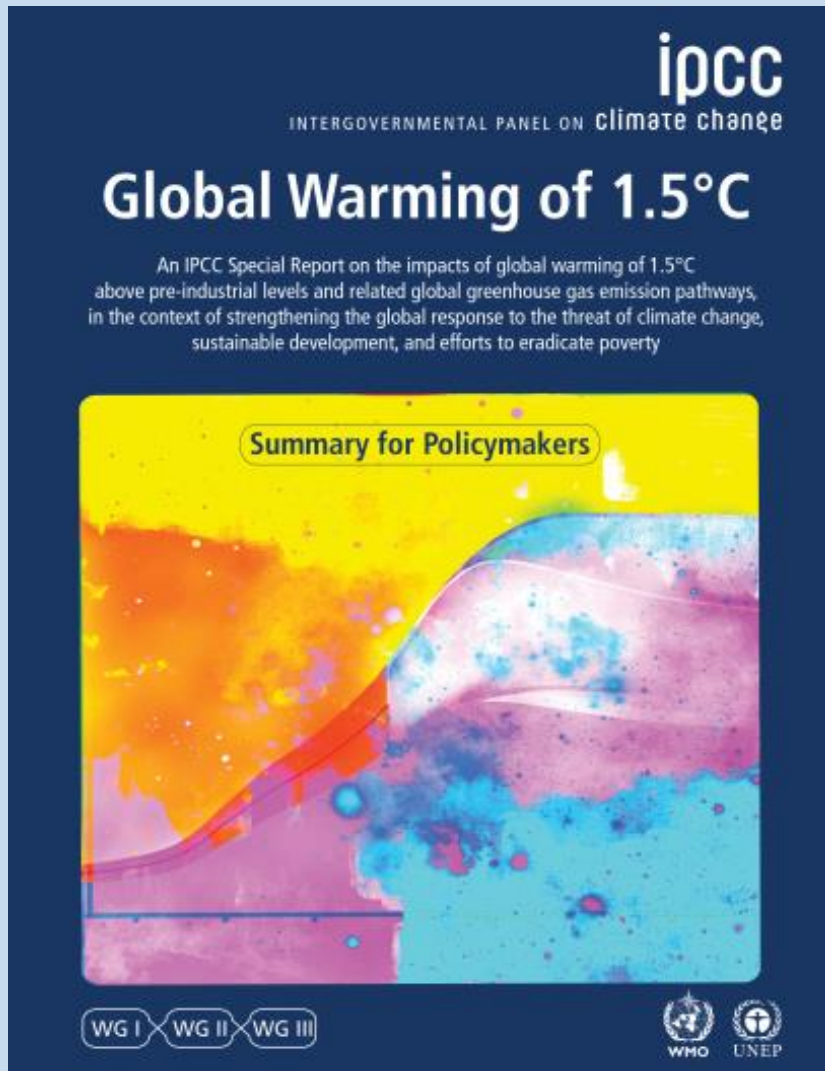
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Remaining carbon budget 1,5 °C

840 Gt CO₂ (33 %)

580 Gt CO₂ (50 %)

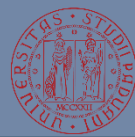
420 Gt CO₂ (67 %)

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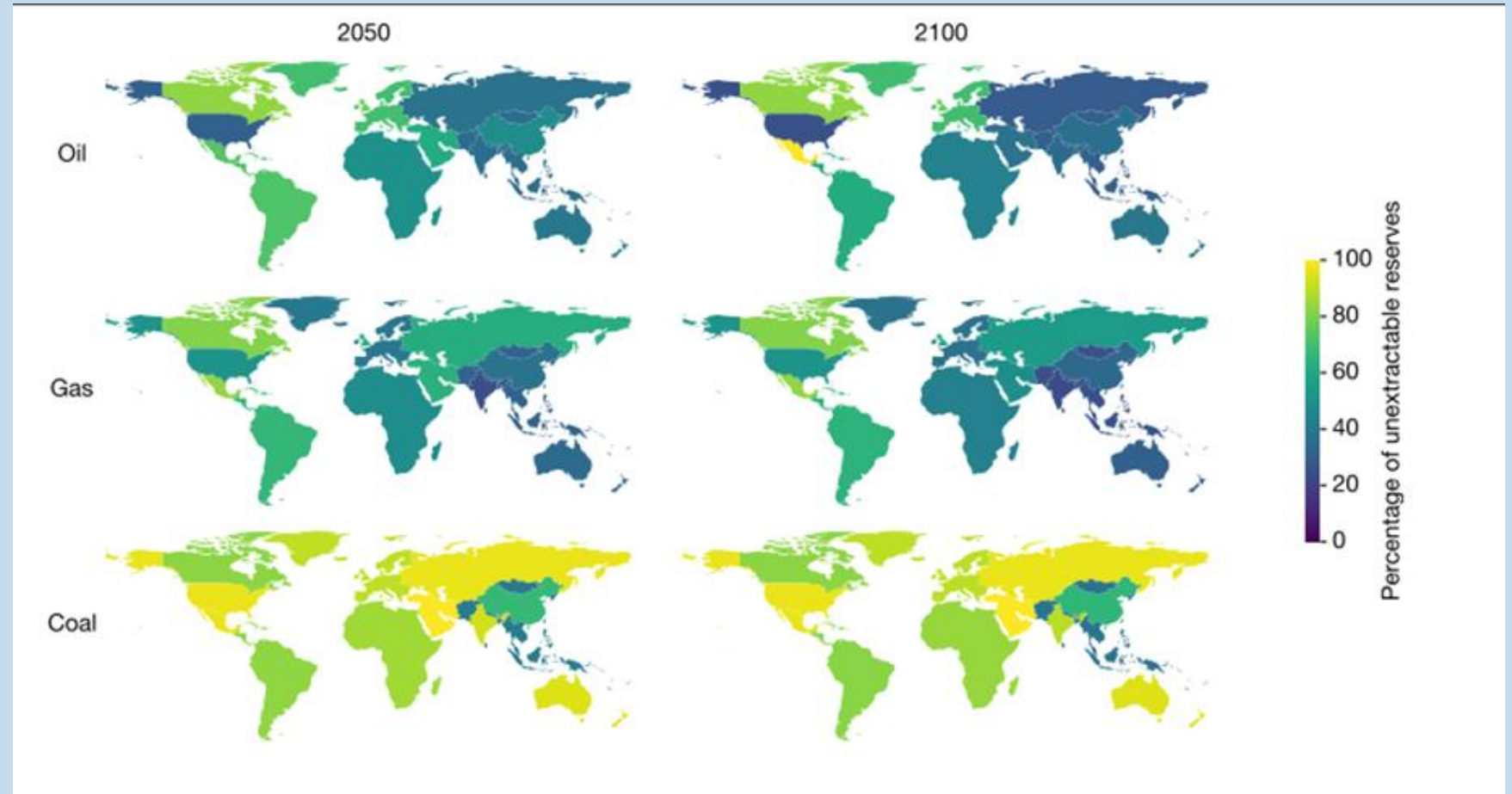
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Unburnable carbon reserves within +1,5 °C

- 58% of oil
- 59% of gas
- 89% of carbon



Welsby D, Price J, Pye S and Ekins P 2021 Unextractable fossil fuels in a 1.5 °C world Nature 597 230–4

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Unleakable carbon

Unleakable Carbon refers to the uncombusted carbon-based gases that are also associated with the extraction, distribution, and consumption of fossil fuel reserves, otherwise referred to as ‘fugitive’, ‘leaked’, ‘vented’, ‘flared’, or ‘unintended’ emissions

Table 1. Given best- and worst-case CH₄ leakage and GWP scenarios we demonstrate that unless unleakable carbon is curtailed, up to 80–100% of our global natural gas reserves must remain underground if we hope to limit warming to 2°C from 2010 to 2050

| GWP | Time horizon (years) | Leakage rate | |
|-----|----------------------|--------------------------|---------------------------|
| | | 1.8% Leakage rate Low | 5.4% Leakage rate High |
| 34 | 100 | 80% | 139% |
| 86 | 20 | 127% | 280% |

Notes: When low and high CH₄ leakage rates (Brandt et al., 2014) are applied to the combustion emissions associated with the utilizable portion of our remaining natural gas reserves, estimated to be 50% if we aim to meet a warming target of 2°C from 2010 to 2050 (McGlade & Ekins, 2015), we find that the warming contribution of unleakable carbon is large enough to enhance CO₂e between 30% and 230% over best- and worst-case leakage and GWP scenarios, respectively. Here combustion emissions are converted to CO₂e to reflect uncombusted CH₄ using the most recent GWP data published for 20- and 100-year time horizons (IPCC, 2013). Stakeholders may need to prepare to leave 80% of remaining global natural gas reserves untouched in a best-case scenario, and all reserves untouched in a worst-case scenario where even current, ongoing CH₄ leakage may present a challenge to limiting warming to 2°C from 2010 to 2050. See Supplementary Materials for details.

Hendrick, M. F., Cleveland, S. & Phillips, N. G. Unleakable carbon. *Clim. Policy* 17, 1057–1064 (2017).

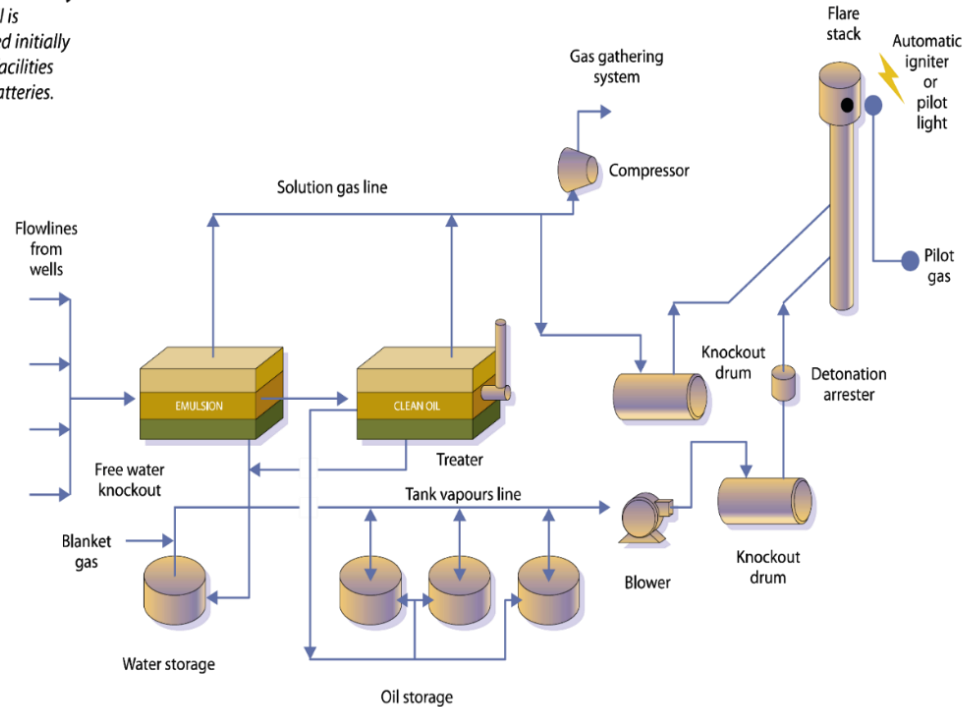
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Gas flaring: “mecheros petroleros”

Crude Oil Battery

Crude oil is processed initially at field facilities called batteries.



©Canadian Centre for Energy Information



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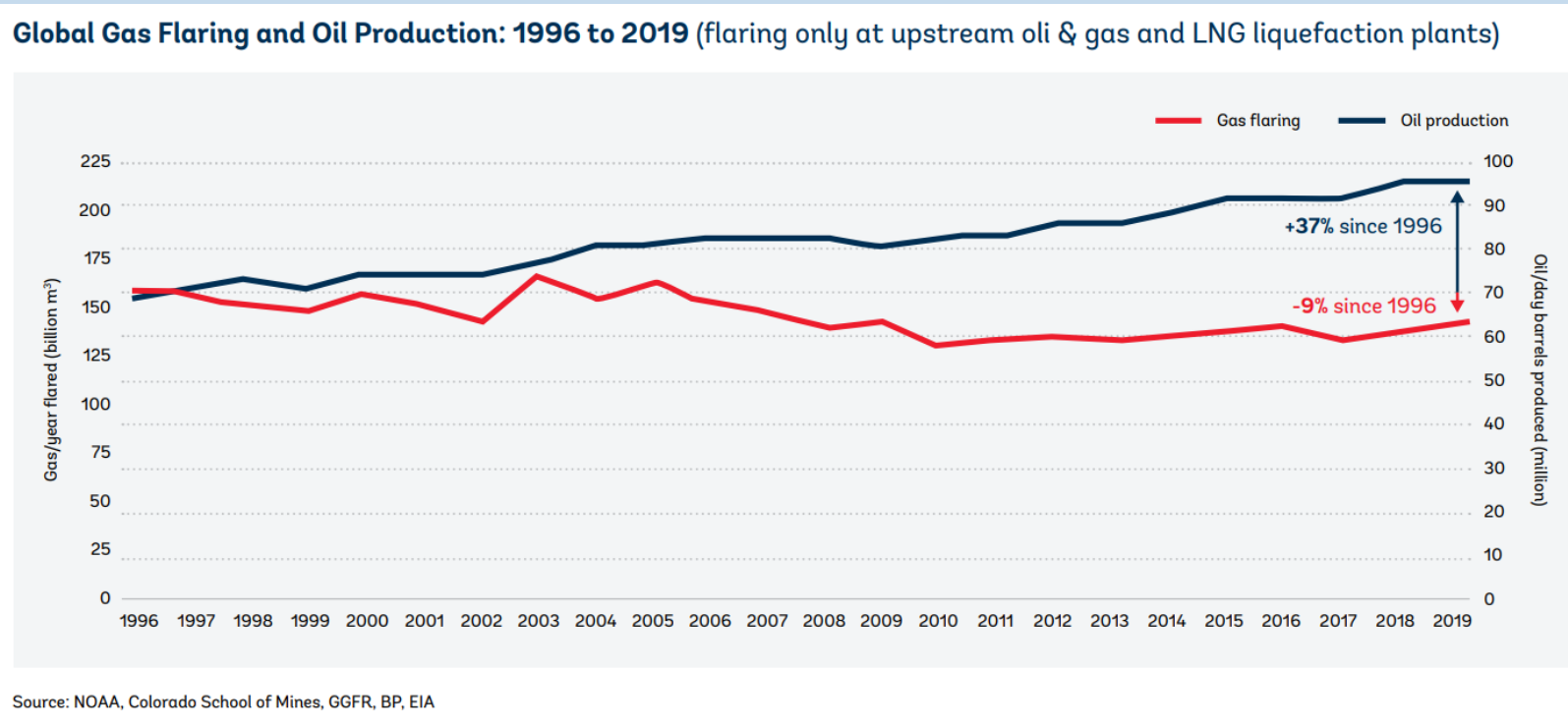
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Gas flaring in the world

- Estimated emission of 300Mt of CO₂ and of 320Gt of black carbon, representing respectively the 1% and the 4% global anthropogenic emissions
- In 2019 were flared about 150 BCM of gas, enough to provide energy to the whole Sub Saharan Africa



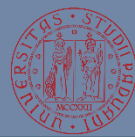
Hendrick, M. F., Cleveland, S. & Phillips, N. G. Unleakable carbon. *Clim. Policy* 17, 1057–1064 (2017).

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Local impacts of gas flaring

- Emission in the atmosphere of over 150 toxic substances including H₂S, SO₂, NO_x, VOC, PAH and black carbon
- Impacts on human health
- Acid rains
- Heat Island, which causes the alteration of the microclimate depending on the flame distance
- Alteration of phenological stages of vegetation and reduction of biomass
- Alteration of biogeochemical cycles of the soil and damages to microfauna



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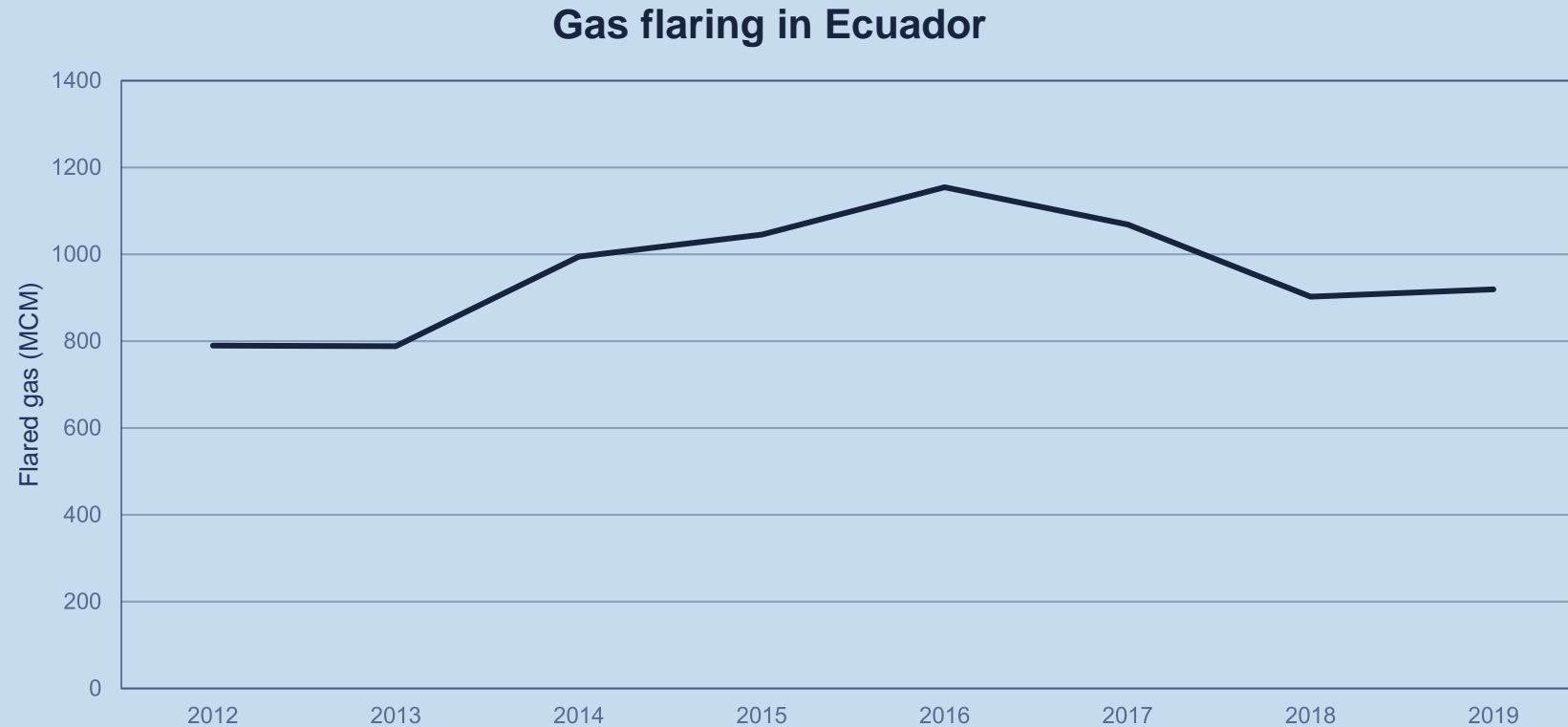
Via Auca (RAE, Ecuador)



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Gas flaring in Ecuador

- 1 BCM yr-1 of gas burned out of a global total of 150 BCM
- 8% of the National Contribution determined by Ecuador during the Paris Climate Agreement.

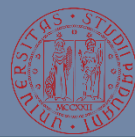


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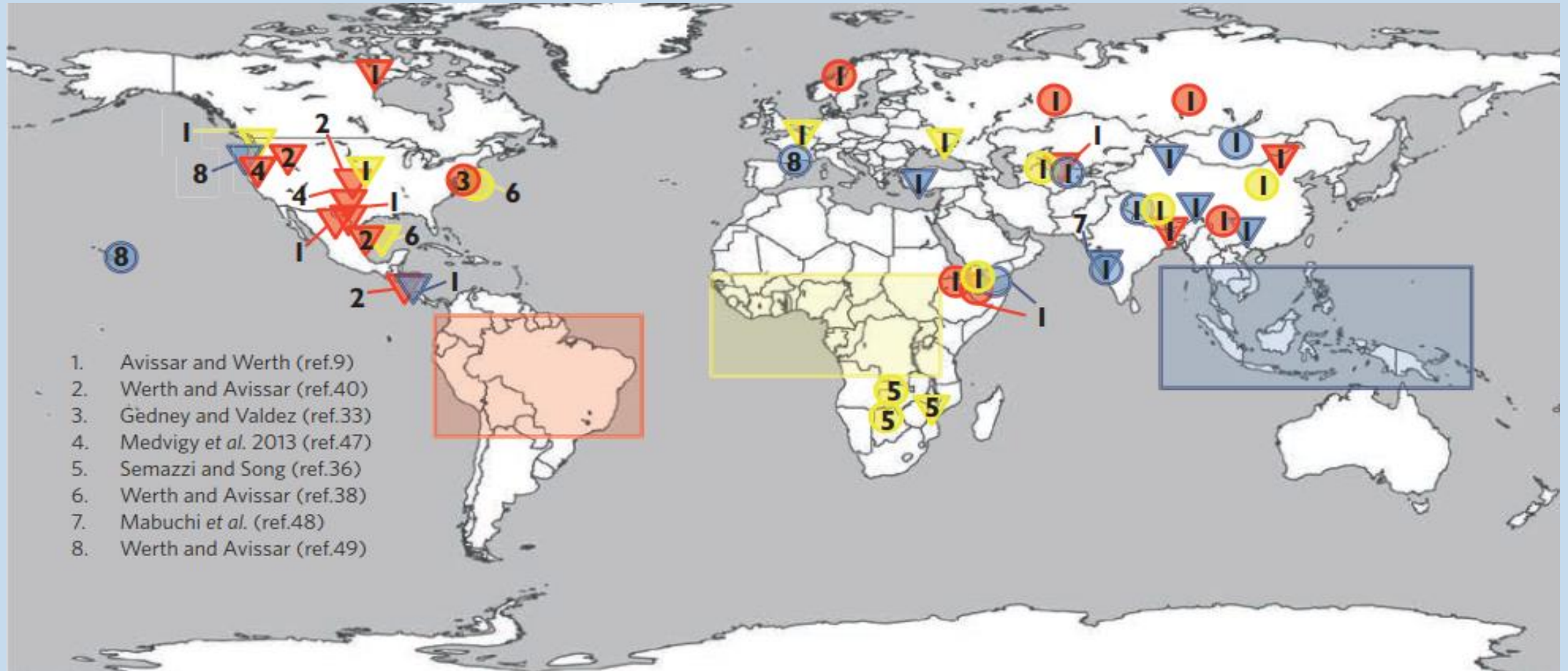


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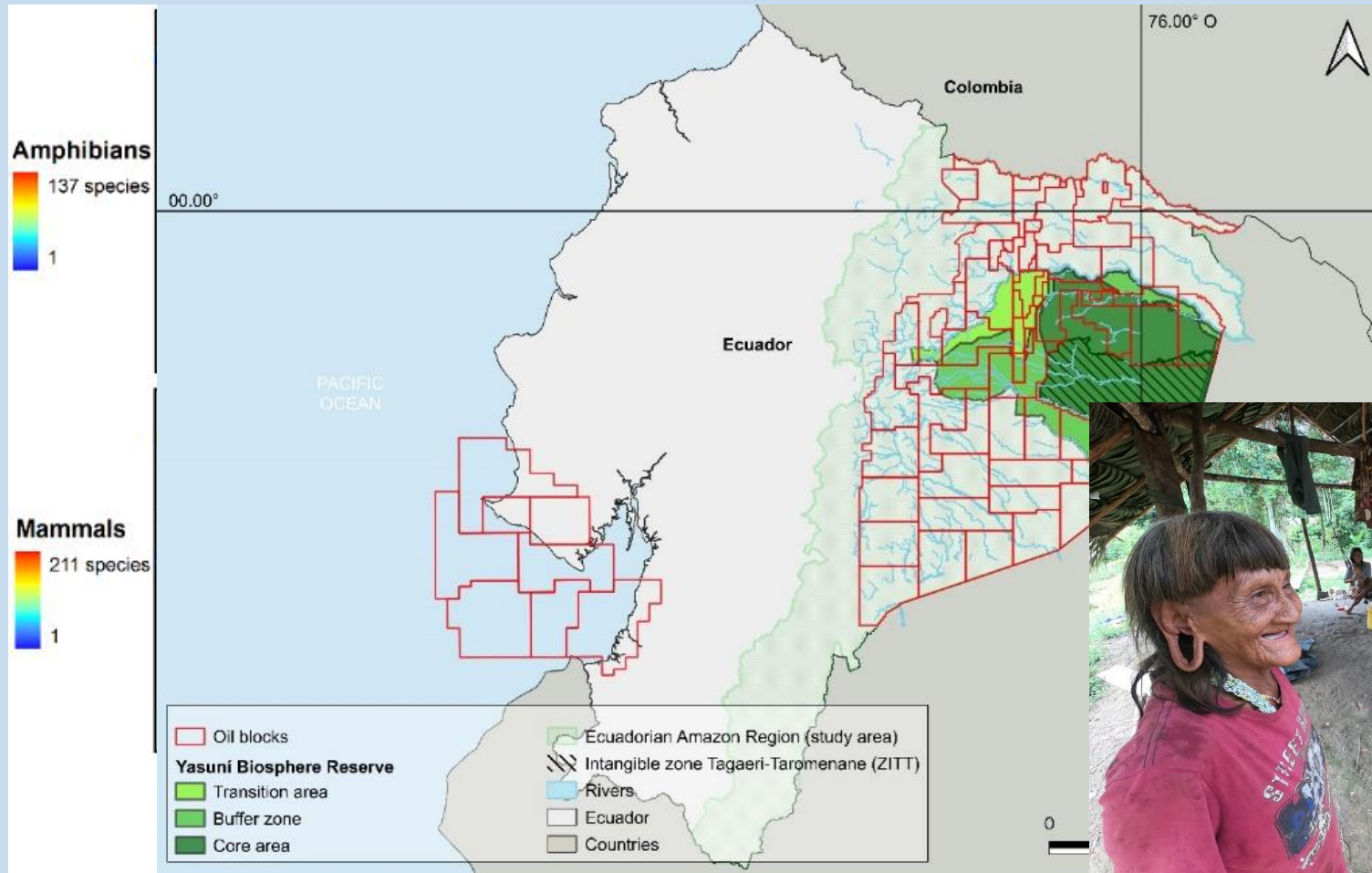
Global importance of the Amazon ...



Lawrence, D., Vandecar, K. Effects of tropical deforestation on climate and agriculture. *Nature Clim Change* 5, 27–36 (2015).
<https://doi.org/10.1038/nclimate2430>

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Geographical Framework: the Ecuadorian Amazon Region

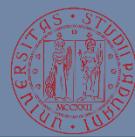


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Involved Organizations

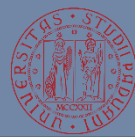


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Participatory framework

CBPAR

- Equal relations
- Involvement in all the phases of the project
- Common goal of a social change

PGIS

GIS-based participatory approach which directly aims to the empowerment of local communities

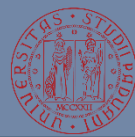
Extreme Citizen Science

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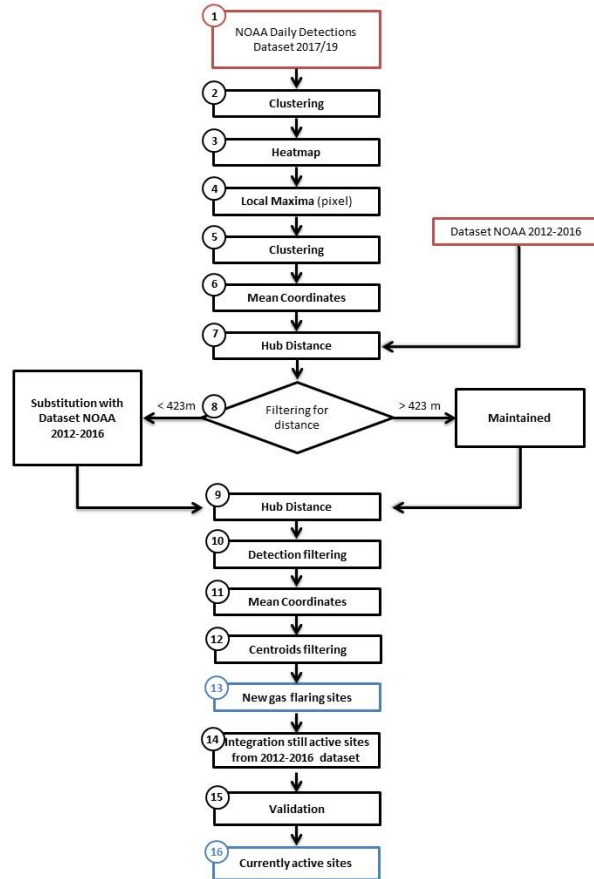
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Data acquisition system

ID: 94
Oil Field: Estacion Drago Norte 1

N -0.1704° E -76.7471°



| Long | Lat | N_plant | N_flame | H_plant_01(m) | H_plant_02(m) | Oil blocks | Oil fields | Operator | Note |
|----------|---------|---------|---------|---------------|---------------|------------|------------|------------------|------|
| -76.7471 | -0.1704 | 2 | 2 | 8 | 8 | 57 | Libertador | Petroamazonas EP | n/a |

Spatial data

Photo

Francesco Facchinelli francesco.facchinelli@unipd.it



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Mapping from below and knowledge transfer



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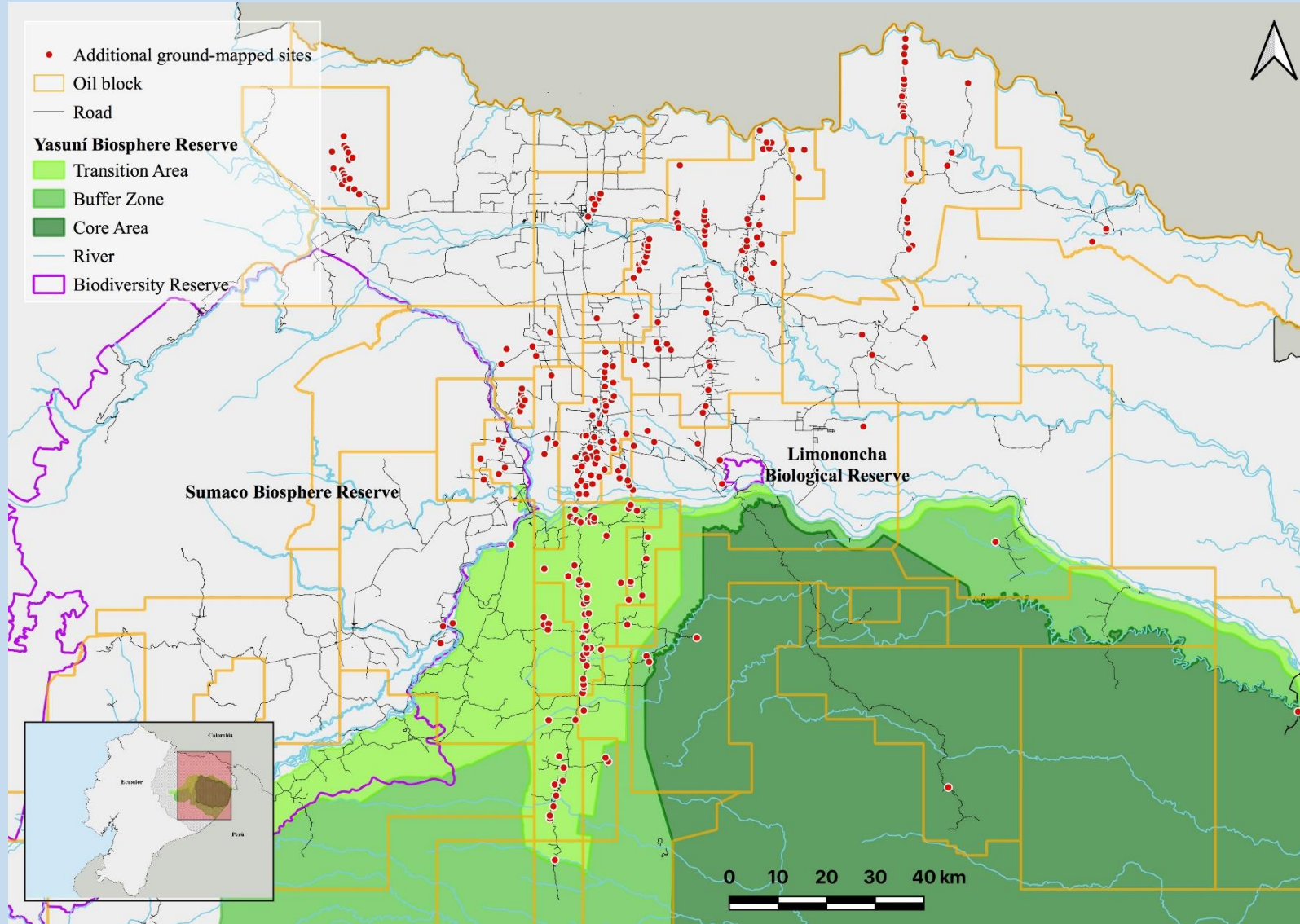


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Participatory mapping



Participatory Mapping

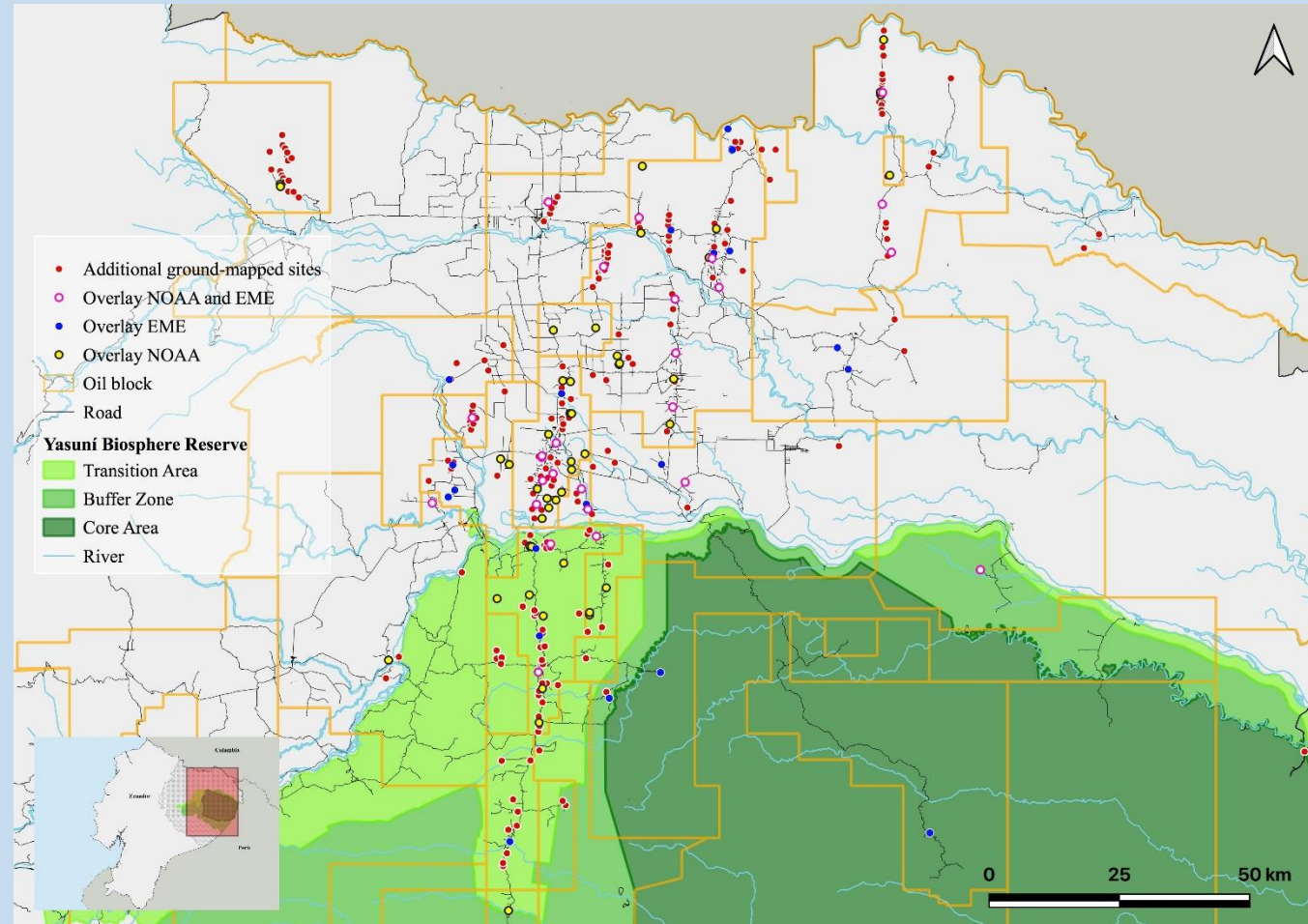
| | Sites | Stacks | Active stacks |
|--------------------|-------|--------|---------------|
| Study area | 305 | 448 | 325 |
| Sucumbíos Province | 141 | 211 | 143 |
| Orellana Province | 159 | 232 | 179 |
| Napo Province | 2 | 2 | 2 |
| Pastaza Province | 3 | 3 | 1 |

Yasuní Biosphere Reserve (UNESCO)

| | Sites | Stacks | Active stacks |
|-------------------|-------|--------|---------------|
| YBR - Total | 76 | 104 | 70 |
| YBR – Core area | 4 | 4 | 4 |
| YBR – Buffer Zone | 5 | 5 | 4 |
| YBR - Transition | 67 | 95 | 62 |



Near real time monitoring and identification of new flares



200 more than satellite
125 more than MAE

Facchinelli, F.; Pappalardo, S.E.; Codato, D.; Diantini, A.; Della Fera, G.; Crescini, E.; De Marchi, M. Unburnable and Unleakable Carbon in Western Amazon: Using VIIRS Nightfire Data to Map Gas Flaring and Policy Compliance in the Yasuni Biosphere Reserve. Sustainability 2020, 12, 58.

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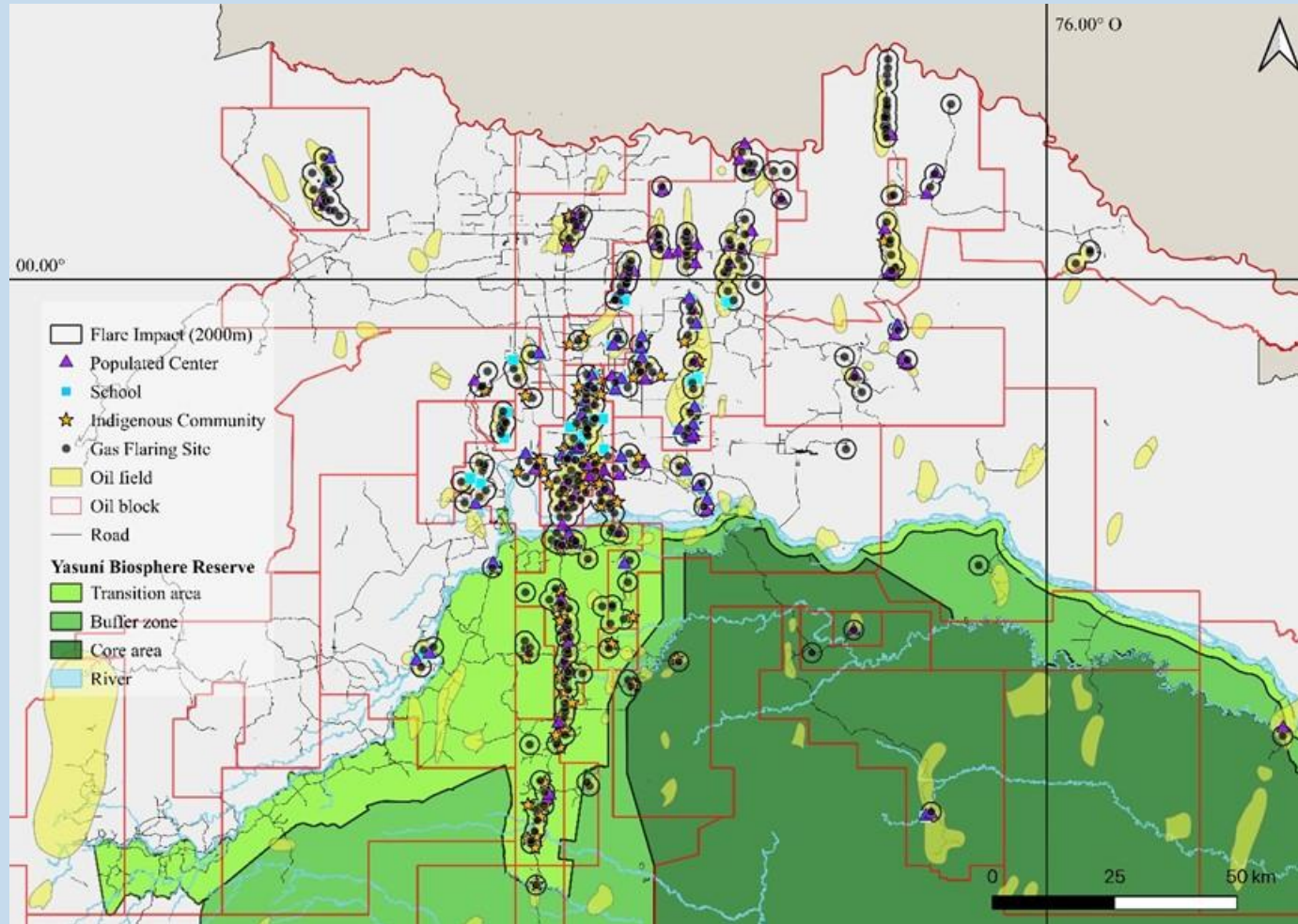


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Identification of threatened communities



86 indigenous communities
62 schools

Facchinelli, F.; Pappalardo, S.E.; Codato, D.; Diantini, A.; Della Fera, G.; Crescini, E.; De Marchi, M. Unburnable and Unleakable Carbon in Western Amazon: Using VIIRS Nightfire Data to Map Gas Flaring and Policy Compliance in the Yasuni Biosphere Reserve. Sustainability 2020, 12, 58.

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Additional Impacts



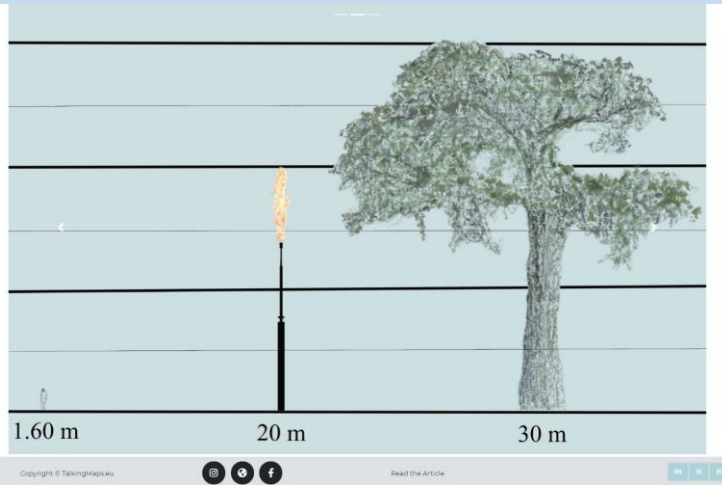
Outcomes

Gas flaring

Gas flaring is an irrational industrial practice that consists of burning waste gases on site, mostly CH₄, along with fossil fuel extraction and energy production processes. It is diffused worldwide, particularly in developing countries, where oil companies do not invest in infrastructures to capture, store and re-use gas from fossil fuel extraction. Hendrick et al. (2016) defined such uncombusted gases as "unleakable carbon", referring to "fugitive", "leaked", "vented", "blasted", or "unintended" GHG emissions [1]. These emissions encompass mainly CO₂ produced from the combustion, and CH₄ due to incomplete combustion or the extinguishing of the flame. Beyond GHG, chemical emissions include many pollutants such as sour gas with H₂S and SO₂, volatile organic compounds (VOCs), Polycyclic Aromatic Hydrocarbons, NOx and soot (black carbon) [2,3]. The role of the unleakable carbon in global warming is crucial, as demonstrated, CH₄ has a global warming potential 86 times greater than CO₂ over a 100 year time horizon, making it one of the most powerful GHGs [2].

Address:
 Dr Hendrick, M.F., Cleveland, K., Phillips, N.G. Unleakable Carbon. *Chem. Policy* 2017, 17, 1887-1894
 Dr Elomari, E.A. Environmental Pollution and Assessment of Gas Flaring. *Int. J. Environ. Res. Pub. Health* 2016, 13, 2621-2627

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Gas flaring distribution

During our work on the field were mapped, both from our group and from local organizations which took part in the participatory mapping process, 305 gas flaring sites, with over 447 flare stacks. Of them, 351 were flaring gas, and 96 of the remaining were venting it directly in the air. For each site, we took GPS point, photos and additional data as the height of the flare stack or the oil well to which the plant was associated. In this way produced a first independent and documented assessment of gas flaring activities in the region. Moreover, these data will allow us to further investigate the reliability of different methods to detect the gas flaring sites from satellite imagery. However, NOAA Nightfire satellite data, show that the various flaring sites coexist with very different amounts of flared volumes. For instance, a recent study of our research work shows that half of the gas flared in 2018 in the Yasuni Biosphere Reserve (about 199 Million Cubic Meter) came from only two different sites. The work was supported from "YASUNIDOS" and "Colectivo de Geografía Crítica" del Ecuador which shared with us our field data and methodology.

| Field | Value |
|---------------|----------------------------------|
| id | 70 |
| Date/yyyymmdd | 2019-05-17 |
| Organization | Universita degli Studi di Padova |
| longitude | -76.70702661 |
| latitude | 0.171429327 |
| photo | |
| h_stack | 2 |
| h_well | 2 |
| h_point_0(m) | 4 |
| h_point_02(m) | 4 |
| h_point_03(m) | 103 |

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GAZES ON THE AMAZON: Lives Within Oil Extraction

Escuela Nueva Loja: studying under the flame

Twino: living near the oil field


When we went in the community "Val Hermoso" we were supposed to make a workshop above gas flaring impacts and the employment of geo-app for smartphone in order to produce reliable documentation during environmental contamination events. Thus, at the end of our presentation, we asked them if there was something which they wanted to document. They asked us to go to an oil waste management area. Luckily, Washington told them to come all with us. If only a few people would come, not only we had not would be able to make them practice with the tools we taught them, but also risked to be stopped from the oil field guards. Now, the waste management area was made of big pools made of earth with some liquids inside. These were the so called "drilling muds", made of water mixed with other substances injected in the oil wells in order to facilitate the soil perforation. After showing us the pools, they took us for a walk around the area, showing us two different points where these formation muds were coming out of the pools going directly into two different rivers. Moreover, they explained us that water from these rivers is employed from different communities, including them, to take bath, to cook and to drink. As reported in scientific literature, in these muds are present many harmful substances as hydrocarbons and heavy metals. After, the president, addressing some signs in her face similar to scars, explained us that it was the result of a skin illness she got being used to wash herself in the river and that many people near there had similar problems. She said it could not be removed and that the company never gave any kind of compensation for it. Despite being really touched from what she said we felt also a strong sense of impotence, doubting to be able to help them, maybe the same that they are feeling since a lot of years. However, they gave us the solution asking us to help them to redact a report, and thanking us for the know-how that we taught them, because now they will be able to report to local authorities whenever they will have trouble due to contamination events. We are still in contact with them, and they are currently asking to local authorities to fix the question.

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<https://www.climate-justice.earth/amazonya/index.html>

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Outcomes



Documento de relación sobre el mapeo de los mecheros en la Región Amazónica de Ecuador

Autores: Francesco Facchinelli¹, Eugenio Pappalardo², Edoardo Crescini¹, Giuseppe Della Fera², Alberto Dianzini³, Daniele Codato², Massimo De Marchi²

¹ Dipartimento Interateneo di Scienze, Progetto e Politiche Del Territorio (DIST), University of Turin, Viale Pier Andrea Mattioli, 39, 10125 Torino;
² Dipartimento di Ingegneria Civile Edile e Ambientale, Università di Padova, Via Marzolo n. 9, Padova, Italia;
³ Dipartimento di Scienze Storiche, Geografiche e dell'Architettura, Università di Padova, Via del Santo n. 26, Padova, Italia; alberto.dianzini@unipd.it

Para obtener una estima independiente y actualizada de los mecheros en el área de estudio se empezó un trabajo de mapeo de largo plazo entre los años 2018 y 2019. Este trabajo fue realizado con la colaboración de la Unión de los Afectados para Texaco (UDAPT), el Colectivo de Geografía Crítica, la Fundación Alejandro Labaka y el proyecto AMAZONYA bajo la supervisión del equipo de investigación "Cambio climático, territorios y diversidades" de la Universidad de los Estudios de Padova, que también se encargó de verificar la integridad y de la elaboración de los datos. Para cada sitio donde había quema de gas se tomaron punto GPS, fotos y se documentó el número de mecheros presentes y su estado de actividad con el fin de clasificar y monitorear las actividades. Los mecheros se presentan con llamas o sin llamas. En algunos sitios se encontraron mecheros sin llama que emitían directamente gases en el aire. Este tipo de practica es llamado en el marco internacional "gas venting" y tiene consecuencias para la salud y el medio ambiente probablemente peores de la quema de gas. Es importante también notar que los presentes datos no pretenden representar una evaluación exhaustiva de todos los mecheros de la Amazonia Ecuatoriana, cuanto establecer una base para permitir de comprender cuanto el fenómeno está ampliamente difundido y evidenciar la necesidad de estructurar un mapeo y monitoreo desde abajo, de forma permanente.

La dinámica de quema de gas en los mecheros es variable y discontinua. En algunos sitios, efectuando el control en diferentes momentos, se constató que algunos mecheros que en inicialmente estaban apagados, después estaban aprendido, evidenciando la natura transitoria de la presencia de la llama, que puede depender por la actividad del pozo o de la presencia de manutención regular por parte la compañía. Por esto se reportaron también las torres sin llama.

En total, se mapearon un total de 305 sitios/plataformas con mecheros, entre los cuales 447 mecheros de los que 351 estaban encendidos, es decir que tenían llama, de las que no tenían llama, 35 estaban emitiendo gas al momento del control.

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 **sustainability**

Unburnable and Unleakable Carbon in Western Amazon: Using VIIRS Nightfire Data to Map Gas Flaring and Policy Compliance in the Yasuní Biosphere Reserve



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Involvement of local NGOs increased the quality of the project (Balazs and Morello-Frosch, 2013)

- Rigor -> increasing in the study area
- Relevance -> inclusion of sites not “seen” from satellite
- Reach -> employment of the data for social changing

Value of the knowledge of local communities

Considerations

Data alone cannot change politics, but can be an important means to formalize the instances of local communities

Potential of Extreme Citizen Science toward the achievement of climate justice

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Thank you for your attention!



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