

A photograph of a person in a yellow shirt standing on a concrete ledge, looking down at a river with brown, polluted water. The background shows some green foliage and a concrete structure.

# Oil extraction related pollution and environmental health

Cristina O'Callaghan Gordo  
Geneva Health Forum, 5<sup>th</sup> of May 2022

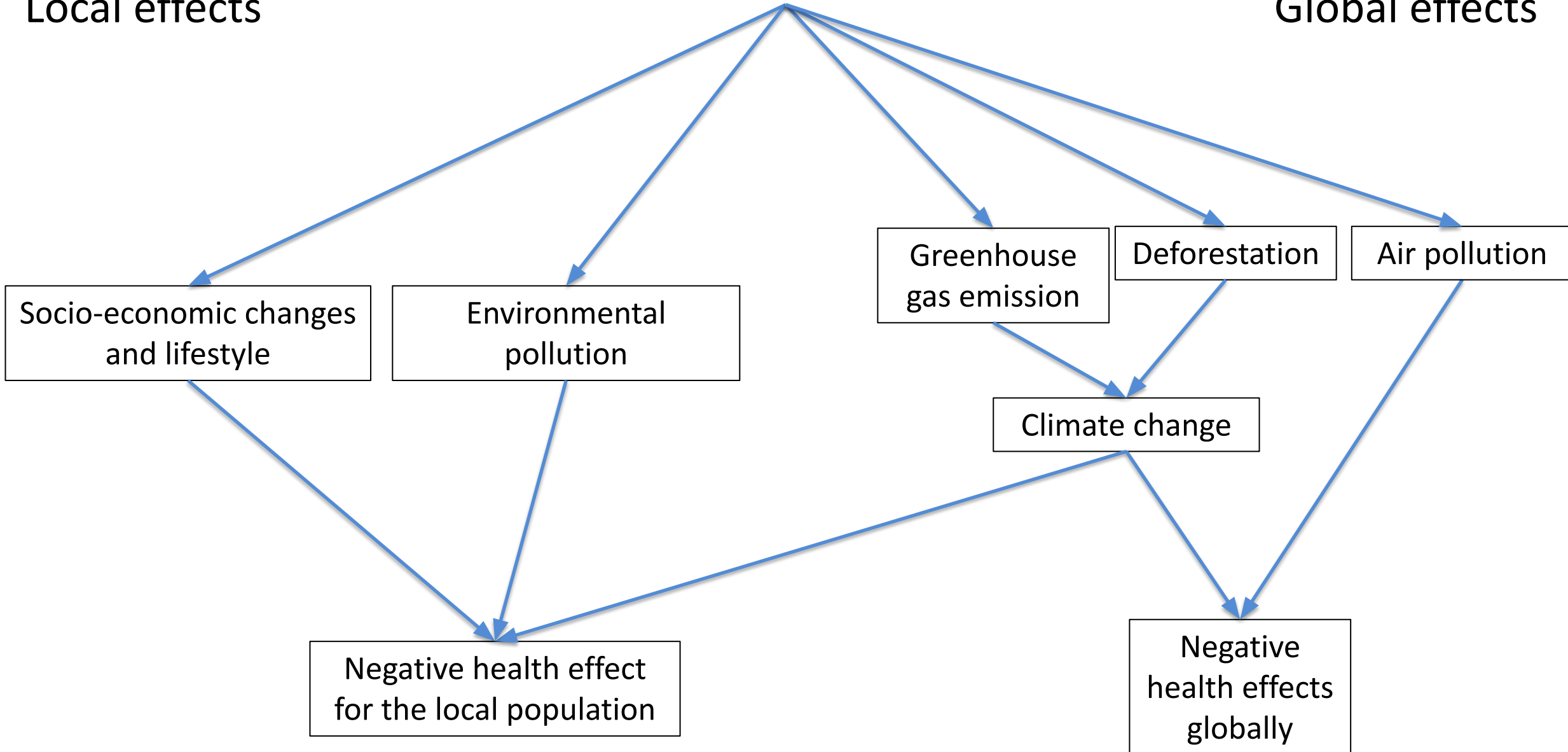
**ISGlobal** **Barcelona**  
Institute for  
Global Health

**UOC** Universitat Oberta  
de Catalunya

# Oil extraction & use

Local effects

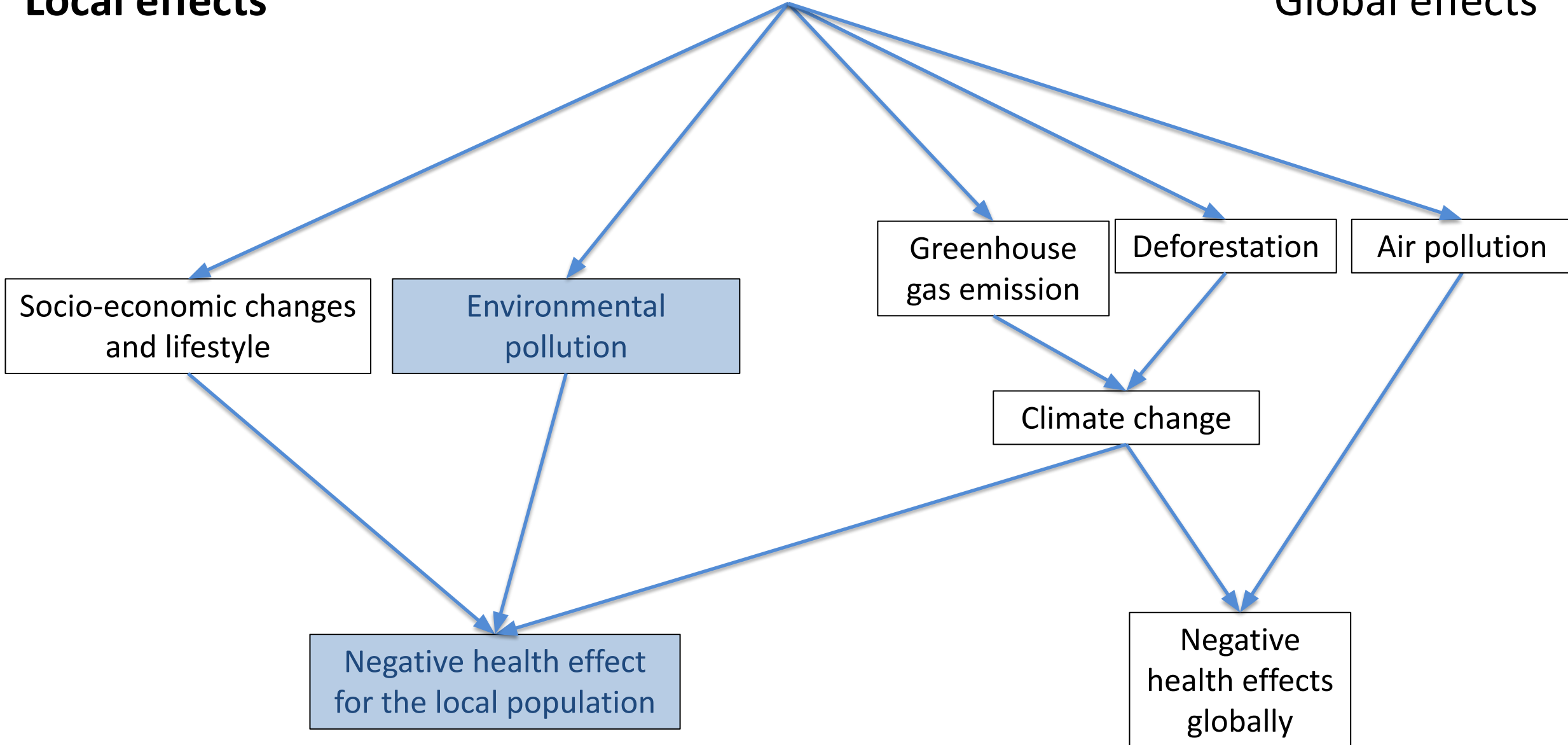
Global effects



# Oil extraction & use

Local effects

Global effects



# Negative health effect for the local population

The health effects of exposure to oil related contamination have been mainly studied after oil spills among cleanup workers and residents of the affected coastal areas (Levy et al. *Int J Occup Environ Health* 2011; Pérez-Cadahía et al. *Environ Health Insights* 2008)


- High levels of metals associated with adverse health effects
- Acute effects: respiratory, eye and skin symptoms, headache, nausea, dizziness and fatigue
- Chronic effects: psychological disorders, lower respiratory tract symptoms and reduction of lung function, genotoxicity and alterations in hormonal status have also been described

The health effects of exposure to oil extraction related contamination poorly studied among people residentially exposed (O'Callaghan-Gordo et al. *Environmental Health* 2016)

O'Callaghan-Gordo et al. *Environmental Health* (2016) 15:56  
DOI 10.1186/s12940-016-0140-1

Environmental Health

COMMENTARY Open Access

 CrossMark

## Health effects of non-occupational exposure to oil extraction

Cristina O'Callaghan-Gordo<sup>1,2,3\*</sup>, Martí Orta-Martínez<sup>4,5</sup> and Manolis Kogevinas<sup>1,2,3,6</sup>

**Abstract**

Oil extraction may cause extensive environmental impact that can affect health of populations living in surrounding areas. Large populations are potentially exposed to oil extraction related contamination through residence in areas where oil extraction is conducted, especially in low and middle income countries (LMICs). Health effects among people residentially exposed to upstream oil industry contaminants have been poorly studied. Health effects of exposure to oil related contamination have been mainly studied among cleanup workers after oil spills from tankers or offshore platforms.

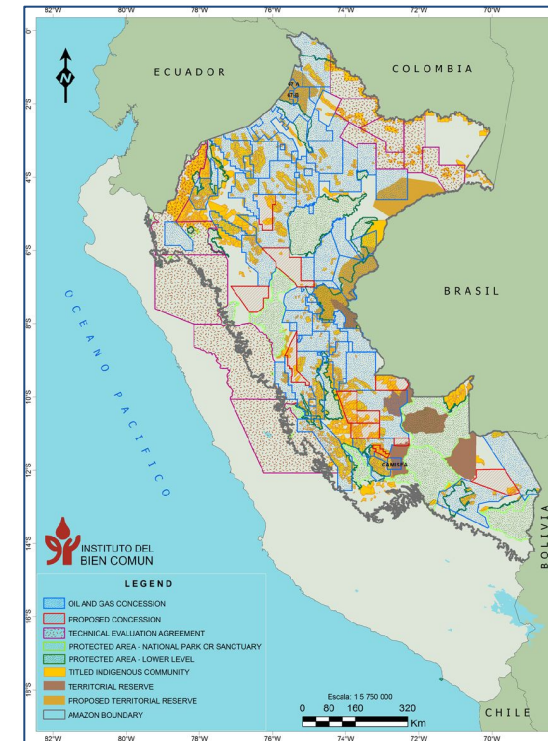
In this paper we aim to identify the type and extension of residential exposures related to oil extraction activities and to comment on the few health studies available. We estimated that 638 million persons in LMICs inhabit rural areas close to conventional oil reservoirs. It is relevant to specifically study people residentially exposed to upstream oil industry for the following reasons: First, persons are exposed during long periods of time to oil related contamination. Second, routes of exposure differ between workers and people living close to oil fields, who can be exposed by ingestion of contaminated waters/foods and by dermal contact with contaminated water and/or land during daily activities (eg. bathing, agricultural activities, etc). Third, individuals potentially more susceptible to the effect of oil related contamination and not normally occupationally exposed, such as infants, children, pregnant women, elderly or people with previous health conditions, are also exposed.

There are few papers studying the potential health effects of residential exposure to oil related contamination, and most of them share important limitations. There is a need for more research through the conduct of methodologically robust studies in exposed populations worldwide. Despite the difficulties in the conduct of studies in remote areas, novel approaches, such as measurement of individual exposure using biomarkers of exposure and effect, should be used. These studies should be promoted to understand the health risks associated to residential exposure to oil related contamination, support effective control policies to avoid such contamination and to sustain public health recommendations and policies to avoid exposure in already contaminated areas.

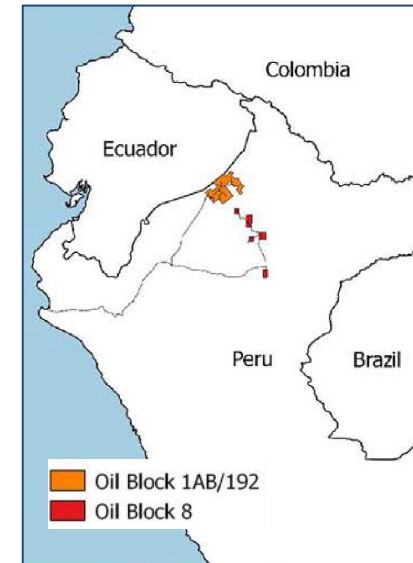
**Keywords:** Oil extraction industry, Non-occupational exposures, Crude oil

# Oil extraction in the Peruvian Amazon

- Extraction activities in the Peruvian Amazon started in the 60's
- Two-thirds of oil extraction areas in the Peruvian Amazon are within indigenous territories
- Overlap also between oil extraction areas and protected areas



Current oil and gas concessions, proposed concessions, technical evaluation agreement lots and protected areas and indigenous peoples' territories in the Peruvian Amazon (Finer & Orta-Martínez, ERL 2010)



Case study area (map prepared by Orta-Martínez)

Recurrent oil spills and poor environmental practices, such as dumping of produced water contaminated this area



1969-71	→	1AB and 8 oil Blocks were leased
1972	→	First Production Well
1974	→	North Peruvian Pipeline
1982	→	Maximum oil production (120.000 bopd)
1984	→	ONERN: "one of the most damaged areas in the country" IIAP: High levels (275ppm) of lead in fish tissues
1998	→	MEM (1998): "High concentrations of TPH, Ba and Pb in samples of surface water"; "Petroleum spills of varying sizes were identified on the surface of rivers and on land"
2004	→	OSINERG (2004): "levels of contamination above maximum permissible limits" due to high TPH in soils and river water
2006	→	MINSA (2006): High levels of cadmium and lead in blood among the local population of this area: 66% of children BLL >10 µg/dl; 79% of adults BLL >10 µg/dl, 99% of children and adults Cd cadmium levels in urine >0.1 µg/dl
2013	→	Peruvian government (2013): state of environmental emergency in the Corrientes, Pastaza and Tigre river basins (RM-263-2013-MINAM, RM-094-2013-MINAM and 370-2013-MINAM)
2014	→	Peruvian government (2014): state of the health emergency in these river basins and in the Marañon river basins (SD-006-2014-SA)

1969-71



1AB and 8 oil Blocks were leased

1972



**First Production Well**

1974



North Peruvian Pipeline

1982



Maximum oil production (120.000 bopd)

1984



ONERN: "one of the most damaged areas in the country"  
IIAP: High levels (275ppm) of lead in fish tissues

1998



MEM (1998): "High concentrations of TPH, Ba and Pb in samples of surface water"; "Petroleum spills of varying sizes were identified on the surface of rivers and on land"

2004



OSINERG (2004): "levels of contamination above maximum permissible limits" due to high TPH in soils and river water

2006



MINSA (2006): High levels of cadmium and lead in blood among the local population of this area: 66% of children BLL >10 µg/dl; 79% of adults BLL >10 µg/dl, 99% of children and adults Cd cadmium levels in urine >0.1 µg/dl

2013



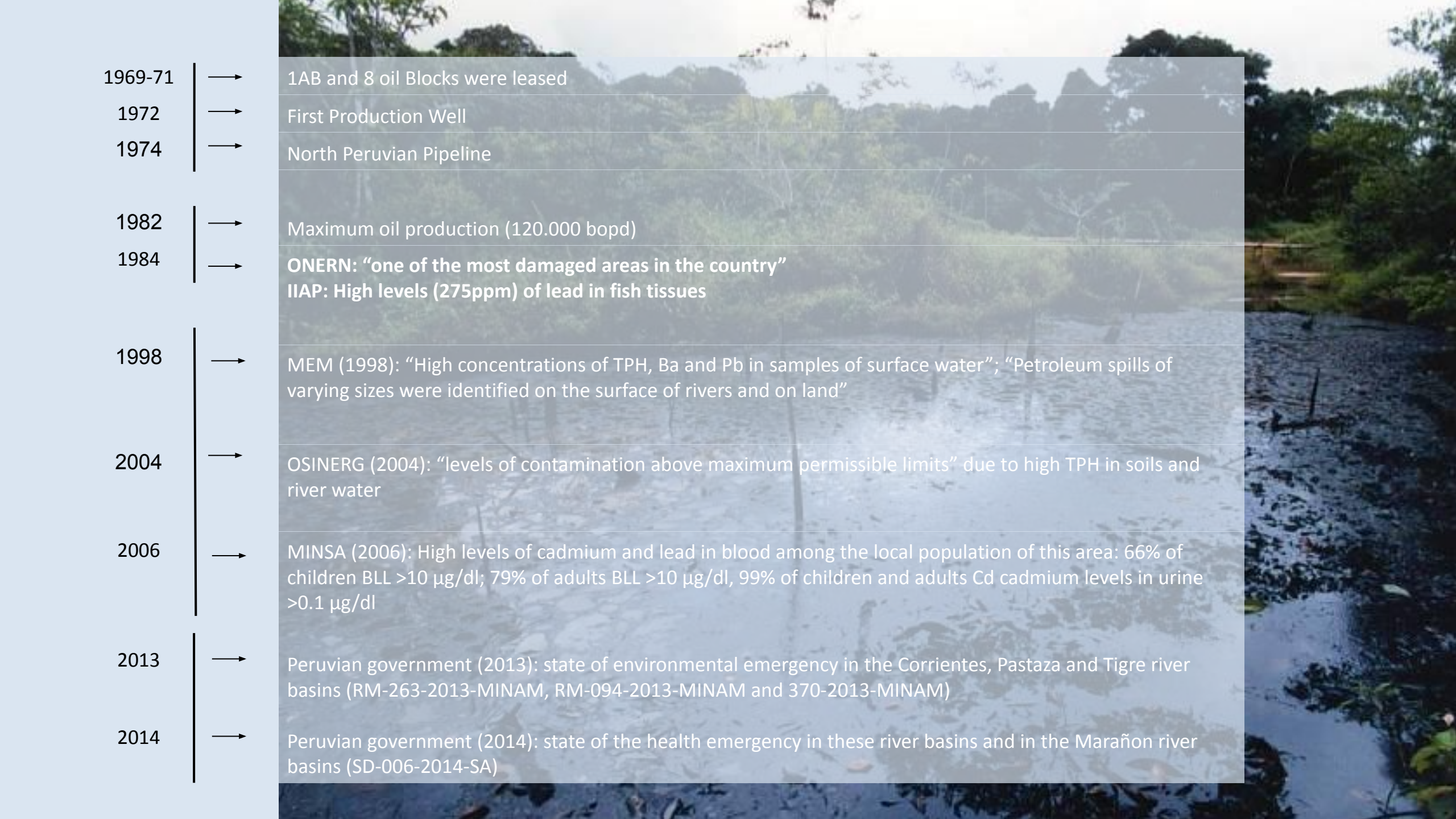
Peruvian government (2013): state of environmental emergency in the Corrientes, Pastaza and Tigre river basins (RM-263-2013-MINAM, RM-094-2013-MINAM and 370-2013-MINAM)

2014



Peruvian government (2014): state of the health emergency in these river basins and in the Marañon river basins (SD-006-2014-SA)





1969-71	→	1AB and 8 oil Blocks were leased
1972	→	First Production Well
1974	→	North Peruvian Pipeline
1982	→	Maximum oil production (120.000 bopd)
1984	→	<b>ONERN: “one of the most damaged areas in the country”</b> <b>IIAP: High levels (275ppm) of lead in fish tissues</b>
1998	→	MEM (1998): “High concentrations of TPH, Ba and Pb in samples of surface water”; “Petroleum spills of varying sizes were identified on the surface of rivers and on land”
2004	→	OSINERG (2004): “levels of contamination above maximum permissible limits” due to high TPH in soils and river water
2006	→	MINSA (2006): High levels of cadmium and lead in blood among the local population of this area: 66% of children BLL >10 µg/dl; 79% of adults BLL >10 µg/dl, 99% of children and adults Cd cadmium levels in urine >0.1 µg/dl
2013	→	Peruvian government (2013): state of environmental emergency in the Corrientes, Pastaza and Tigre river basins (RM-263-2013-MINAM, RM-094-2013-MINAM and 370-2013-MINAM)
2014	→	Peruvian government (2014): state of the health emergency in these river basins and in the Marañon river basins (SD-006-2014-SA)

1969-71



1AB and 8 oil Blocks were leased

1972



First Production Well

1974



North Peruvian Pipeline

1982



Maximum oil production (120.000 bopd)

1984



ONERN: "one of the most damaged areas in the country"  
IIAP: High levels (275ppm) of lead in fish tissues

1998



MEM (1998): "High concentrations of TPH, Ba and Pb in samples of surface water"; "Petroleum spills of varying sizes were identified on the surface of rivers and on land"

2004



OSINERG (2004): "levels of contamination above maximum permissible limits" due to high TPH in soils and river water

2006



**MINSA (2006): High levels of cadmium and lead in blood among the local population of this area: 66% of children BLL >10 µg/dl; 79% of adults BLL >10 µg/dl, 99% of children and adults Cd cadmium levels in urine >0.1 µg/dl**

2013



Peruvian government (2013): state of environmental emergency in the Corrientes, Pastaza and Tigre river basins (RM-263-2013-MINAM, RM-094-2013-MINAM and 370-2013-MINAM)

2014



Peruvian government (2014): state of the health emergency in these river basins and in the Marañon river basins (SD-006-2014-SA)

1969-71



1AB and 8 oil Blocks were leased

1972



First Production Well

1974



North Peruvian Pipeline

1982



Maximum oil production (120.000 bopd)

1984



ONERN: "one of the most damaged areas in the country"  
IIAP: High levels (275ppm) of lead in fish tissues

1998



MEM (1998): "High concentrations of TPH, Ba and Pb in samples of surface water"; "Petroleum spills of varying sizes were identified on the surface of rivers and on land"

2004



OSINERG (2004): "levels of contamination above maximum permissible limits" due to high TPH in soils and river water

2006



MINSA (2006): High levels of cadmium and lead in blood among the local population of this area: 66% of children BLL >10 µg/dl; 79% of adults BLL >10 µg/dl, 99% of children and adults Cd cadmium levels in urine >0.1 µg/dl

2013



**Peruvian government (2013): state of environmental emergency in the Corrientes, Pastaza and Tigre river basins (RM-263-2013-MINAM, RM-094-2013-MINAM and 370-2013-MINAM)**

2014



**Peruvian government (2014): state of the health emergency in these river basins and in the Marañon river basins (SD-006-2014-SA)**

Not a  
problem from  
the past



**VIDEO: NUEVO DERRAME DE  
PETRÓLEO EN LOTE 192 AFECTA  
A COMUNIDADES ACHUAR  
NUEVO NAZARETH Y NUEVO  
JERUSALÉN**

 20 febrero, 2018

El petróleo ha llegado a casas de las familias. La fuente de agua de la comunidad también se ha contaminado. La población indígena reclama que la empresa petrolera Frontera Energy preste ayuda con agua y alimentos, y que el Estado declare en emergencia la zona. PUINAMUDT,

Fotografía: FECONACOR (Federación de Comunidades Nativas de la Cuenca del Corrientes)

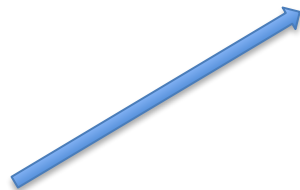
# Health risks – Lead exposure

- Cross-sectional study to assess levels of exposure to lead in the local population and establish risk factors for exposure
- May and June 2016
- 1047 participants from 39 indigenous communities selected (out of 60)
- Information on socio-demographic variables and information on occupational/environmental exposures was collected in structured questionnaires
- Concentrations of lead in blood using atomic absorption spectrophotometry (AAS)



- Mean BLL in the study population was higher than 5 µg/dL
- 49% of children and 60% of adults had BLL above this threshold

Variable	Category	< 12 years old, n=309		≥ 12 years old, n=738	
		n (%)	GM (95%CI)	n (%)	GM (95%CI)
Age (years), median (IQR)		7 (4)	-	35 (24)	-
Sex	Male	152 (49%)	6.2 (5.4, 7.1)	347 (47%)	7.8 (7.2, 8.4)
	Female	157 (51%)	4.0 (3.5, 4.5) **	391 (53%)	4.3 (4.0, 4.7) **
River basin	Marañón	70 (23%)	2.4 (2.0, 3.0)	167 (23%)	3.1 (2.7, 3.4)
	Pastaza	95 (31%)	4.2 (3.6, 4.9)	262 (36%)	5.2 (4.8, 5.7)
	Tigre	21 (7%)	6.5 (5.1, 8.2)	60 (8%)	9.2 (8.1, 10.4)
	Corrientes	123 (40%)	8.0 (7.1, 9.0) **	249 (34%)	8.4 (7.6, 9.2) **



Important differences by river basin

\*\* p-value for ANOVA <0.001

Environment International 154 (2021) 106639

Contents lists available at ScienceDirect

Environment International

Journal homepage: [www.elsevier.com/locate/envint](http://www.elsevier.com/locate/envint)

Blood lead levels in indigenous peoples living close to oil extraction areas in the Peruvian Amazon

Cristina O'Callaghan-Gordo<sup>a,b,c,d,e,f,g,h,i,j,k,l,m,n,o,p,q,r,s,t,u,v,w,x,y,z</sup>, Jaime Rosales<sup>a</sup>, Pilar Lizárraga<sup>a</sup>, Frederica Barclay<sup>f</sup>, Tami Okamoto<sup>g</sup>, Diana M. Papoulina<sup>h</sup>, Ana Espinoza<sup>i,j,k,l</sup>, Marti Orta-Martinez<sup>l,k</sup>, Manolis Kogevinas<sup>m,n,o,p,q</sup>, John Astete<sup>r</sup>

<sup>a</sup> Faculty of Health Sciences, Universidad Oberta de Guayaquil, Guayaquil, Ecuador, Spain  
<sup>b</sup> IISGM, Barcelona, Spain  
<sup>c</sup> Universidad Pompeu Fabra (UPF), Barcelona, Spain  
<sup>d</sup> Centro de Epidemiología y Salud Pública (CESPUSP), Lima  
<sup>e</sup> Centro Nacional de Salud Ocupacional y Promoción del Ambiente para la Salud, Instituto Nacional de Salud, Perú  
<sup>f</sup> Centro de Estudios de Población y Desarrollo Humano - Perú, Instituto de Investigación y Promoción del Población y Desarrollo Humano, Perú  
<sup>g</sup> Department of Geography, University of Cambridge, Cambridge, UK  
<sup>h</sup> ILSH International, UK, USA  
<sup>i</sup> ILSH (Hospital del Mar Medical Research Institute), Barcelona, Spain  
<sup>j</sup> Instituto de Ciencias y Tecnología Ambiental, Universidad Autónoma de Barcelona, Barcelona, Catalonia, Spain  
<sup>k</sup> Instituto de Geografía, Universidad San Francisco de Quito, Quito, Ecuador

ARTICLE INFO

Handling Editor: Shoji Nakayama

Keywords:

Lead  
Blood lead levels  
Oil extraction  
River basin  
Environmental contamination  
Indigenous health

ABSTRACT

**Background:** High blood lead levels (BLLs) have been previously reported in indigenous people living in communities in the northern Peruvian Amazon. Oil extraction activities have been conducted in the area since the 1970s and have been identified as a source of lead exposure.

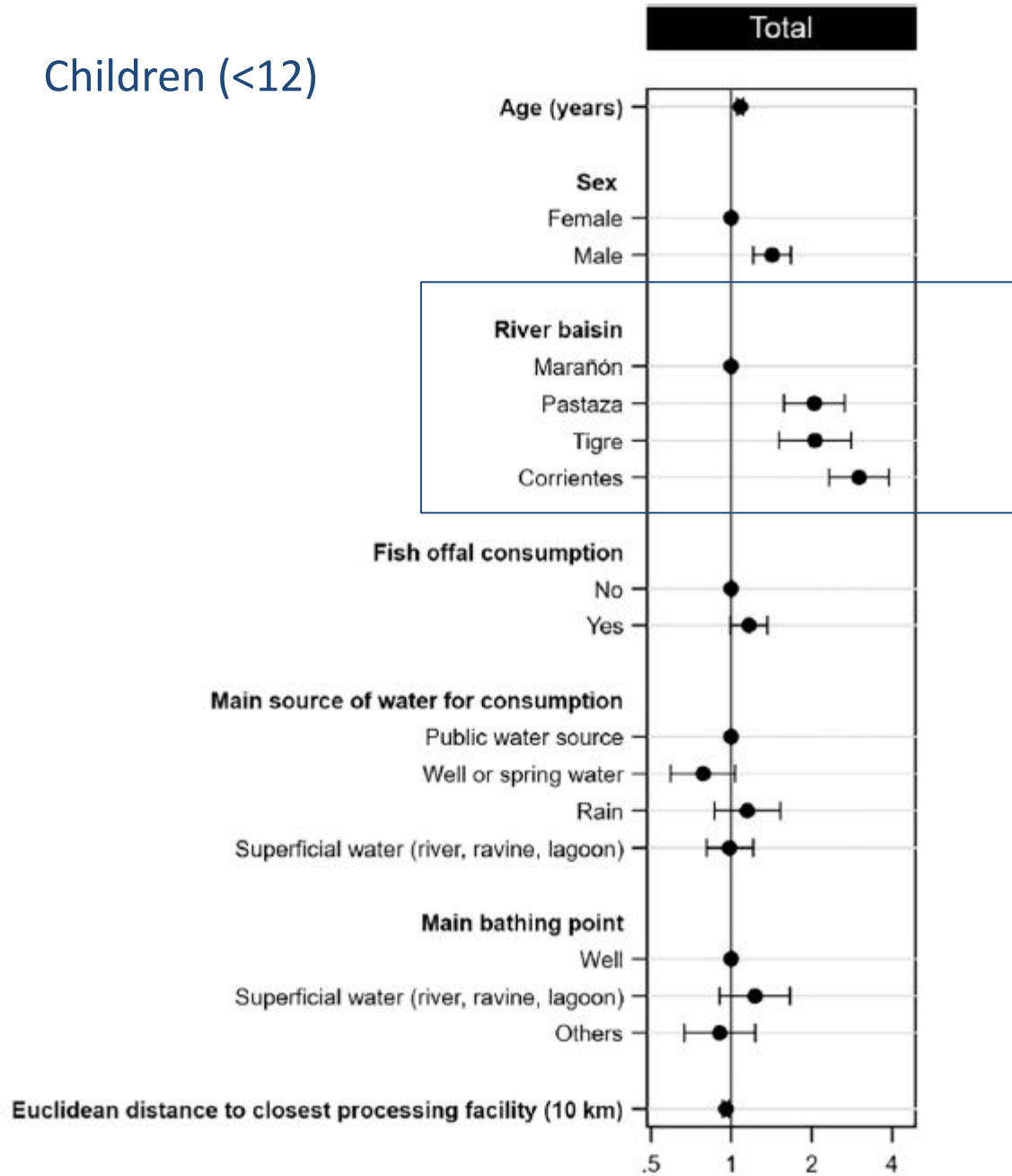
**Objective:** Measure BLL and assess risk factors associated with BLL among indigenous populations from four river basins of the northern Peruvian Amazon.

**Methods:** Participants from 39 communities were selected using a two-stage stratified random selection strategy and were visited between May and June 2016. Information on risk factors was collected using structured questionnaires and blood samples were taken. Overall, complete information was available from 1047 individuals (309 < 12 years old, 738 ≥ 12 years). BLL was determined using atomic absorption spectrophotometry in a graphite chamber. Weighted linear logistic regression models were used to study the association between socio-demographic variables, self-reported life-style factors, environmental, geographical and occupational exposures and BLLs.

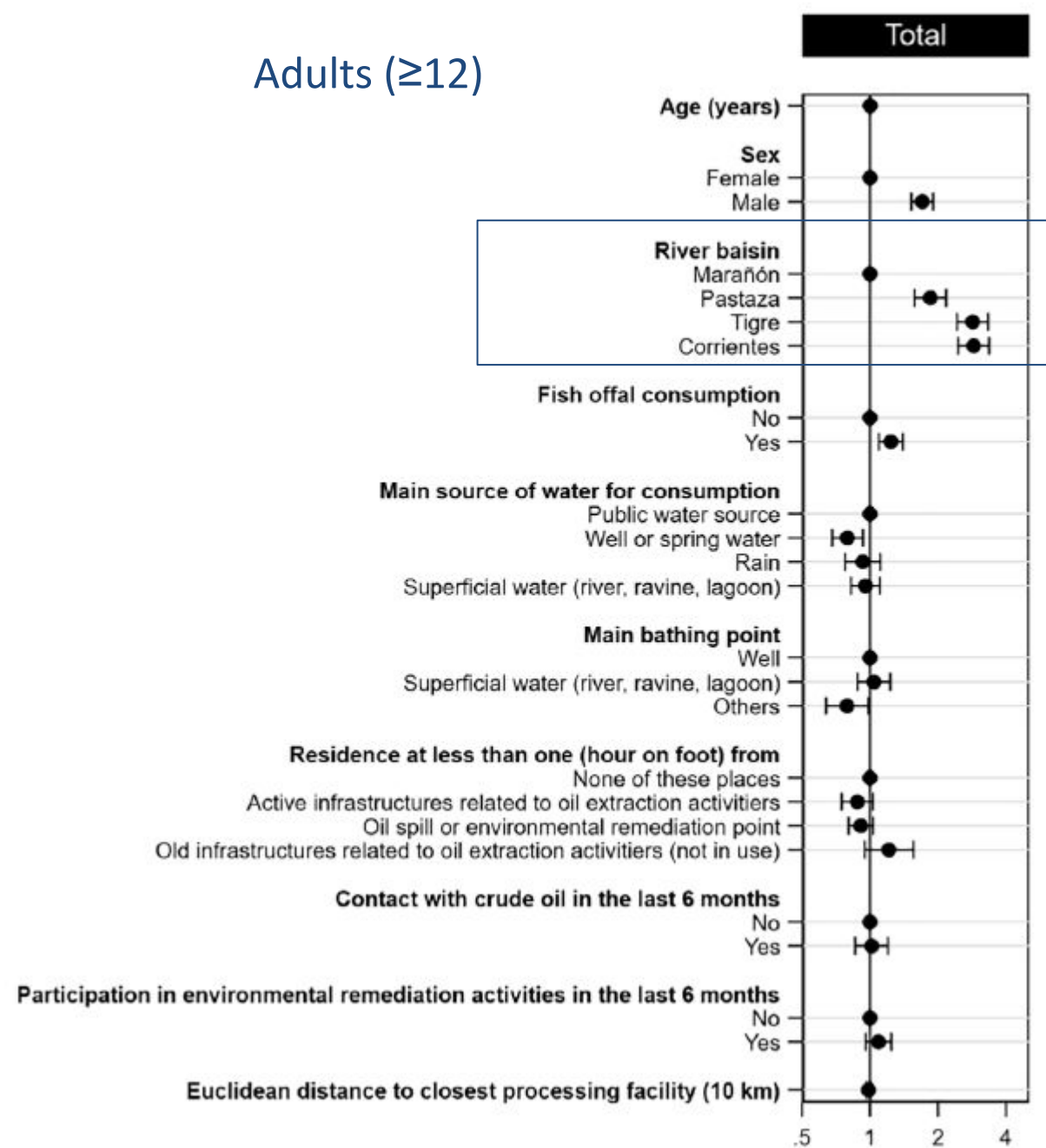
**Results:** Geometric mean (95% CI) BLL was 4.9 (4.5, 5.4) µg/dL in participants <12 years and 5.7 (5.4, 6.0) µg/dL in older participants. There were marked differences in BLL between river basins with the highest levels observed in the Corrientes river basin (8.1 (7.2, 9.1) µg/dL <12 years and 8.8 (8.0, 9.6) µg/dL older participants). High BLL was associated with older age, being male, living in the Pastaza, Tigre or Corrientes river basins and consumption of fish, oil in children and adults. Increased facilities distance between residence and oil production facilities was associated with a small reduction in BLL.

**Conclusion:** BLL that pose a health risk were detected in the study population of a non-industrialized and remote area of the Amazon. The highest BLLs were observed in those river basins where relative oil extraction activity and environmental levels of contaminants have been reported to be greatest.

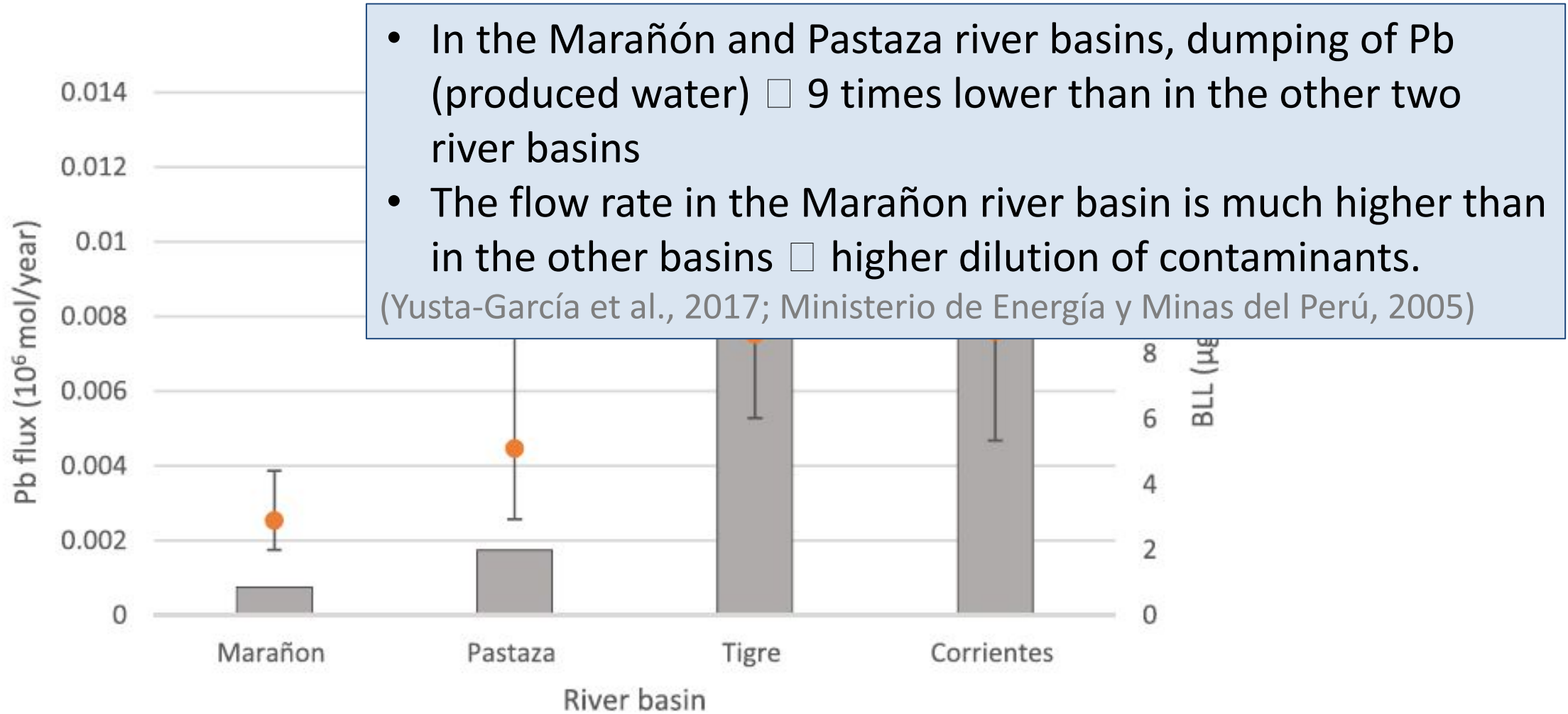
# Children (<12)



# Adults (≥12)



Estimated average lead flux ( $10^6$  mol/year) from dumping of produced water in 2008 in the Marañón, Pastaza, Tigre and Corrientes river basins (extracted from Yusta-García et al. 2017) and BLL ( $\mu\text{g}/\text{dL}$ ) detected in the current study in the same river basins

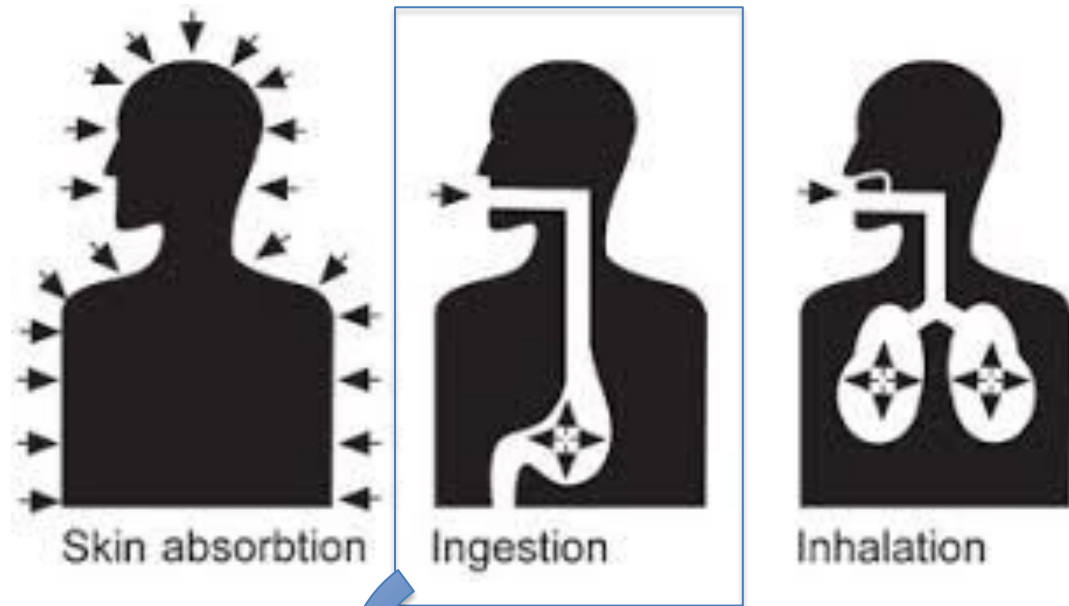


- In the Marañón and Pastaza river basins, dumping of Pb (produced water) is 9 times lower than in the other two river basins
- The flow rate in the Marañón river basin is much higher than in the other basins, leading to higher dilution of contaminants.

(Yusta-García et al., 2017; Ministerio de Energía y Minas del Perú, 2005)



# Routes of exposure for the local population



Is consumption of wild game an important source of exposure to lead?



(Orta-Martinez et al, ER 2017)



Trap cameras in:  
**3 natural salt licks**  
**15 oil-polluted sites**



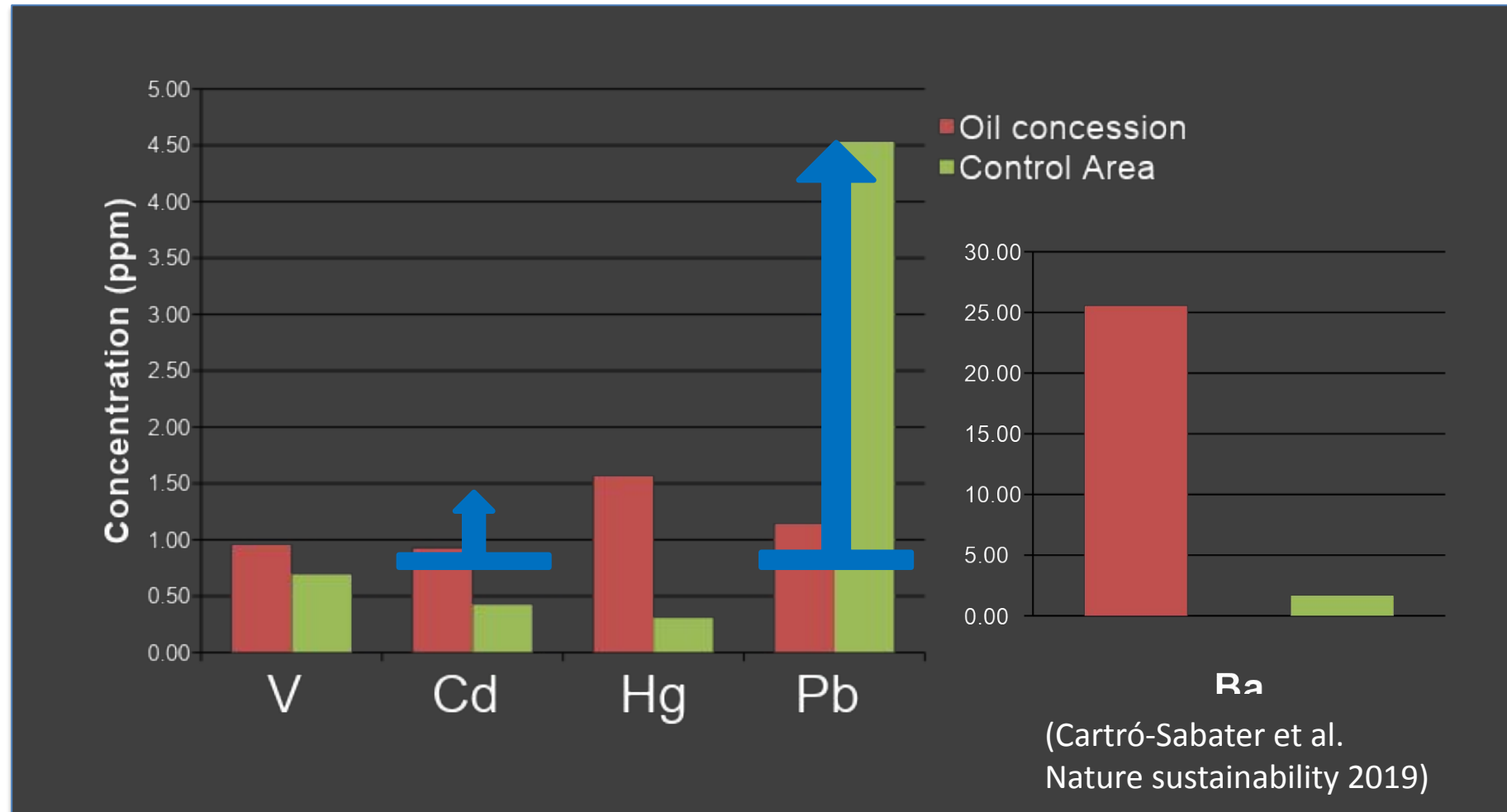
**2083 camera-days**  
**8,206 videos**  
**+**  
**Soil collection**



✓ Species recorded  
**ingesting**  
soil/water in oil  
polluted salt licks

**Species recorded in oil-polluted salt licks represent 49%-68% of hunted biomass** (Bodmer and Lozano 2010; Zapata-Ríos et al. 2009)

- High average concentration of Pb (0.49  $\mu\text{g/g}$  WW) in livers from Amazonian wild game
- 50 % of the samples had Pb above acceptable limits of offal for human consumption (0.5  $\mu\text{g/g}$  WW), (European Regulation CE 1881/2006 on viscera for human consumption (Cd and Pb))



# Final remarks (I)

- Our study shows extensive oil pollution and human exposure at all ages
- Very important to have valid data on environmental exposures and conditions of life of understudied populations
- Practically impossible to conduct long term cohort studies similar to what was done in HICs. We don't need these complex studies to act!

## Final remarks (II)

- Negative health effect of oil extraction activities are major issue of global health inequities  Local communities in the Amazons are a clear example
- Important issue of empowerment of local populations

## **ISGlobal, Barcelona, Spain**

- Manolis Kogevinas
- Ana Espinosa

## **Universitat de Barcelona, Barcelona, Spain**

- Martí Orta Martínez

## **ICTA-UAB, Barcelona, Spain**

- Pedro Mayor
- Mar Cartro

## **CENSOPAS-INS, Lima, Peru**

- Antonio Flores
- Pilar Lizárraga
- John Astete

## **Pontificia Universidad Católica del Perú, Lima, Peru**

- Tami Okamoto

## **E-Tech International, Santa Fe, NM, USA**

- Diana M. Papoulias

## **Centro de políticas Públicas y Derechos Humanos - Perú Equidad, Lima, Peru**

- Frederica Barclay

## **Indigenous federations**

- FECONACOR
- FECONAT
- FEDIQUEP
- ACODECOSP
- PUINAMUD

