

Has Drug Production in Mexico Contributed to Deforestation?

Yeeun Moon

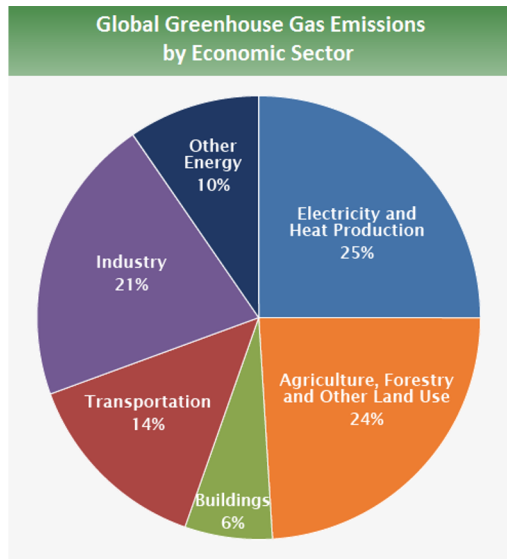
Research Mentor: P.h.D candidate James Sayre

Faculty Sponsor: Dr. Sofia Villas-Boas

Department: Agricultural & Resource Economics

UCB Rausser College of Natural Resources

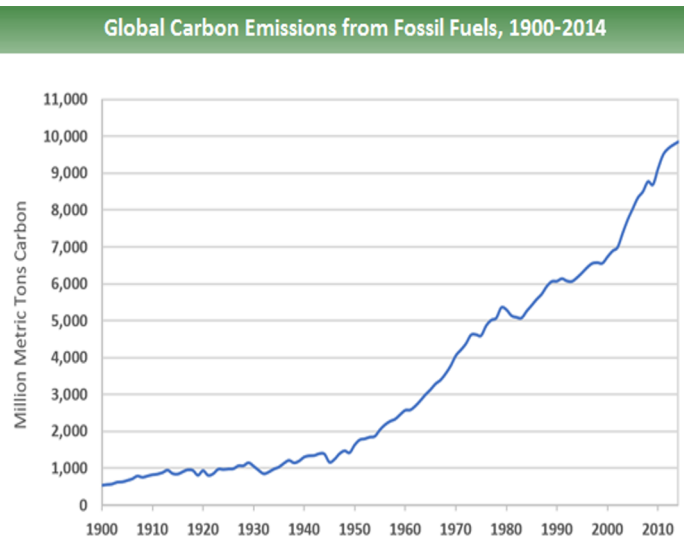
Climate Crisis



Source: IPCC (2014)

- >95% probability that anthropogenic activities over the past 50 years have warmed our planet (IPCC, 2014)

Emissions Trend



Source: T.A., Marland, G., and Andres, R.J. (2017)

- Since 1970, CO₂ emissions have increased by about 90%
- Agriculture, deforestation, and other land-use changes have been the second largest contributor

Forest's Role

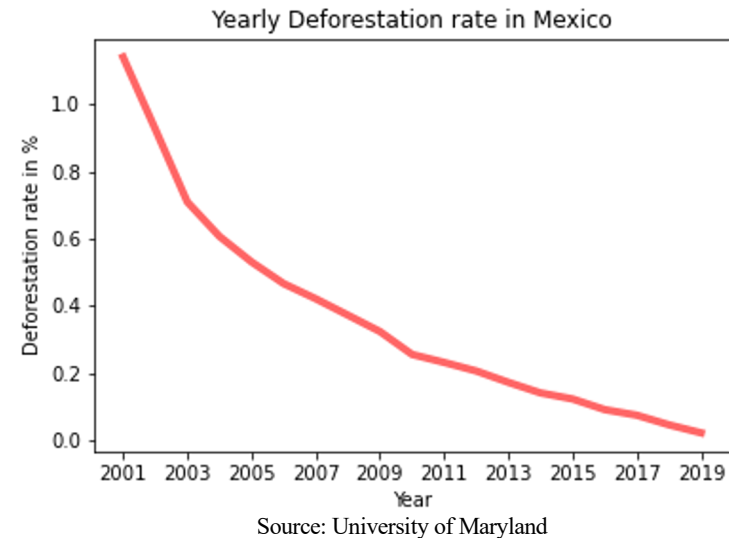
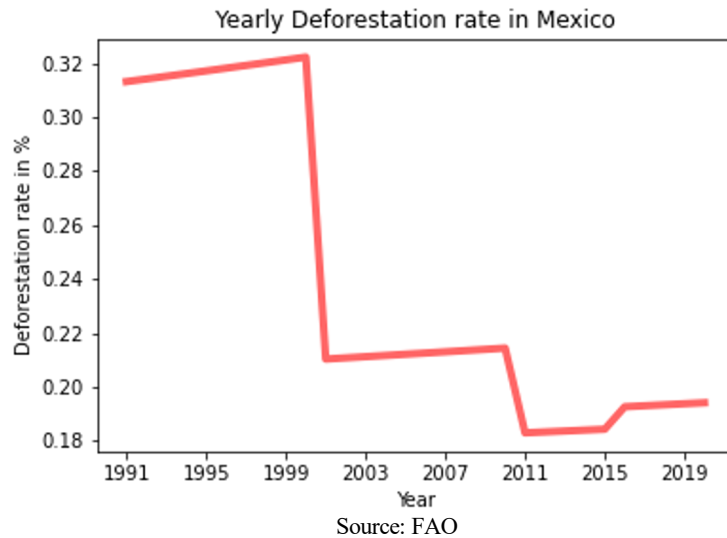


- Carbon sequestration
- Biodiversity
- Sustainable production of natural resources
- Food security

Background

- Identifying the sources of deforestation is critical for climate change mitigation/adaptation and biodiversity conservation for apparent negative externalities associated with forest loss
- Growing observations of the environmental effects of illegal economies in studies:
 - Illegal logging (Hosonuma et al., 2012; Lawson et al., 2014)
 - Land grabbing (Davis et al., 2015; Ruilli et al., 2012)
 - Crop production (Dávalos et al., 2011; Grau and Aide, 2008)
 - Cocaine transit (Devine et al., 2018; McSweeney et al., 2018, 2017)
 - Narcotrafficking (Tellman, 2019)
- However, lack of causal inference due to the challenges of constructing reliable quantitative data
⇒ Does opium poppy production has a causal effect on deforestation (tree cover changes) ?
- Mexico is a significant source and transit country for heroin, marijuana, and synthetic drugs (INCSR, 2019) and among the most biologically diverse countries in the world
- We analyzed tree cover changes between 2000 and 2019 to quantify the impact of opium poppy production on yearly deforestation rate in Mexico

Methods

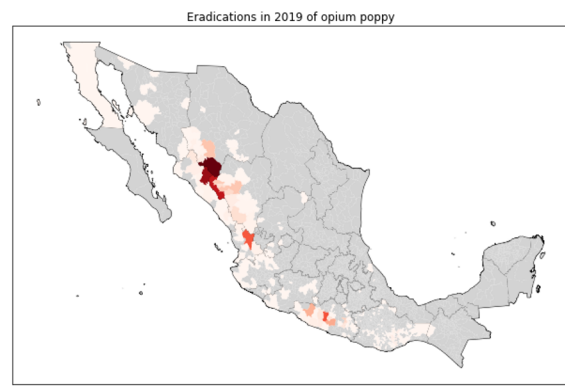


- Amass data from publicly available remote-sensed time-series analysis of Landsat imagery in Mexico made available by the University of Maryland to detect forest cover loss in 2000-2019
- Publicly available information on marijuana and opium poppy eradication undertaken by the Mexican Secretariat of Defense (SEDENA, by its initials in Spanish) as a proxy for production

Deforestation and illicit crop cultivation trends in Mexico



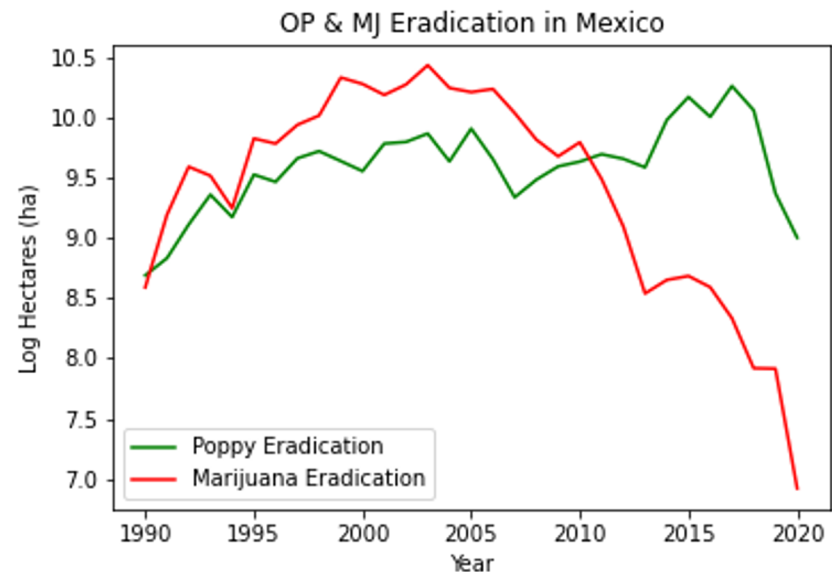
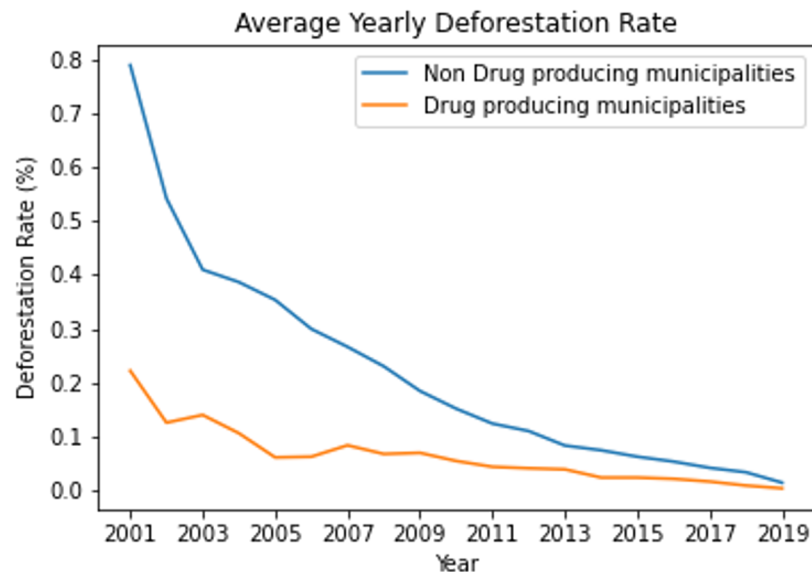
Source: SEDENA



Source: University of Maryland

- Majority of opium poppy and marijuana grows in a line running down the Sierra Madre Occidental from Sonora, Chihuahua, Sinola, Durango, and Nayarit, through Jalisco, Colima, Michoacán and Guerrero, south to Oaxaca and Chiapas (NORIA, 2019)
- Majority of tree cover losses over the last two decades happened in Quintana Roo, Yucatan, Campeche, Tabasco, Veracruz-Ilave, etc but some forest loss occurring in major drug producing states

Deforestation and illicit crop cultivation trends in Mexico



- Since 1990, it is estimated that 420 million hectares (ha) of forest have been lost worldwide though the yearly rate of forest loss has declined over the past three decades from 16 million ha to 10 million ha (FAO 2020)
- Declining Marijuana production could be explained by many farmers substituting from marijuana to opium poppies during the second boom in Mexican heroin market (2000~2016)

Effect of illicit crop production on deforestation (proxied by poppy and marijuana eradication)

VARIABLES	<u>Percent Change in Tree Cover</u>		
	(1) OLS	(2) Fixed Effects	(3) Fixed Effects
eradicated_poppy_ha	0.109 (0.277)	-0.250 (0.155)	0.169** (0.0800)
eradicated_mj_ha	-5.108* (2.986)	0.762** (0.310)	-0.479* (0.285)
Constant	-1.952*** (0.0388)	-0.316*** (0.0249)	0.0317** (0.0138)
N	19,117	11,140	11,140
Type	PPML	PPML	PPML
MuncodeFE		YES	YES
YearFE			YES

Robust standard errors in parentheses, with PPML the results should be interpreted as if the dependent variable were logged. *** p<0.01, ** p<0.05, * p<0.1

Effect of illicit crop production on deforestation (proxied by poppy and marijuana eradication)

VARIABLES	Percent Change in Tree Cover				
	(1)	(2)	(3)	(4)	(5)
eradicated_poppy_ha	0.105* (0.0559)	0.129** (0.0624)	0.0573** (0.0291)	0.0849* (0.0496)	0.0200 (0.0178)
eradicated_mj_ha	-0.291* (0.158)	-0.348* (0.194)	-0.133* (0.0736)	-0.242* (0.133)	-0.0734* (0.0428)
Log (total_ha_planted_allcrops)	0.0559 (0.0440)			0.0758 (0.0482)	0.114*** (0.0290)
Log (tot_pop)		-1.481*** (0.255)		-1.243*** (0.256)	-1.477*** (0.375)
Log (housing_units)			-1.161*** (0.300)		-0.0219 (0.102)
Constant	-0.785** (0.387)	12.39*** (2.111)	10.27*** (2.572)	9.320*** (2.107)	11.34*** (2.980)
Observations	9,860	8,805	5,870	7,540	4,640
MuncodeFE	YES	YES	YES	YES	YES
YearFE	YES	YES	YES	YES	YES
Type	PPML	PPML	PPML	PPML	PPML

Robust standard errors in parentheses, with PPML the results should be interpreted as if the dependent variable were logged.

*** p<0.01, ** p<0.05, * p<0.1

Limitations

- Reverse Causality
 - Is forest loss driving drug production?
 - I.e. is drug production correlated with the error term?
- Measurement Error
 - Clandestine nature of illicit crop cultivation
 - Eradication as a proxy for production most likely be incomplete
 - Forest loss
 - Time-series analysis of Landsat images in characterizing global forest change from 2000 through 2019 defines forest loss as a change from a forest to non-forest state
 - Encoded as either 0 (no loss) or else a value in the range 1-17, representing loss detected primarily in the year 2001–2019, respectively
 - To recover actual tree cover in a given year we made the following assumption:

Base year** tree cover- (Base year tree cover/tree loss detected)*(year-2000)

**Base year = 2000

Conclusion

In this study we have shown that:

- (1) Opium poppy production have a negative effect on the forest extent. In the case study of Mexico, 1 ha increase in poppy production is associated with 9% increase in yearly deforestation rate
- (1) Eradication may drive deforestation directly by:
 - (a) degrading the soil quality and forest remnants
 - (b) pushing farmers out of traditional hotspots into new lands
- (1) Forest loss could be driving illicit crop production