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## **Women, deforestation, and civil society organizations in the Brazilian Amazonia**

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### **1. Introduction**

Study cases and anecdotal evidence indicates that, due to unpaid care responsibilities and underpaid opportunities in a segmented job market, women in Latin America (and elsewhere) suffer unique impacts from deforestation. These include an increase in unpaid work hours and a decrease in the production of craft goods due to the lower supply of forestry resources. Given the importance of forestry resources in supporting women's livelihoods, promoting gender equality is then closely connected with preserving and reversing the decline in these resources. This raises the question of whether decreases in forestry resources increases the presence of institutions focused on promoting gender equality in the Amazonian region.

Shandra *et al.* (2008) argue that, in countries of the Global South, the task of collecting firewood is mostly performed by women, since the activities that require the use of that material – such as cooking, pottery and the production of alcohol, both for subsistence and for sale – are also primarily executed by them. Given that deforestation makes the availability of firewood more costly (in terms of hours worked and energy spent) and has a chain effect in other activities, women's advocacy organizations started targeting deforestation as an important factor to tackle female poverty and gender inequality, particularly in terms of unpaid working hours dedicated to the household and decreasing income opportunities for women.

There are, however, other impacts of deforestation that disproportionately affect women in the household. The collection of wild-caught meat, fish, wild fruits, vegetables, poles, weaving

materials, thatch, medicinal plants, and general resources for the production of artisanal work is mostly made by women, and used both for household subsistence and trade (Cavendish, 2000). It is estimated that eighty percent of households in lower-income countries are reported to use forest products on a daily basis, and three-quarters of poor people living in rural areas depend on forests for subsistence (IFAD 2004, Tieguhong & Nkamgnia 2012). Further, around 1 billion people rely on wild foods to supplement their diets (Shackleton 2014), and women are mostly responsible not only for the collection and preparation of the food, but also for providing care for individuals affected by malnutrition.

The effects of deforestation on rural populations' health is also felt through increasing levels of mosquito-transmitted diseases, particularly rising cases of malaria (Olson et al., 2010; Brock et al., 2019). The usage of fuels other than firewood for cooking and heating, such as agricultural crops and dung, are also associated with impoverishment of health conditions, due to the toxic smoke produced by the burn of such materials (Dankelman and Davidson, 1988; Buckingham-Hatfield, 2000; Katz and Monk, 1993).

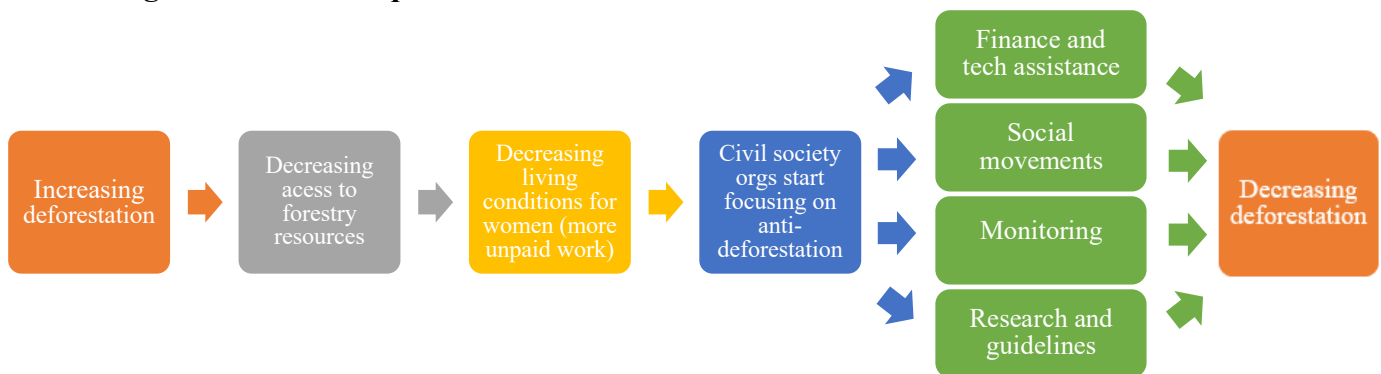
Since most of those results are observed in case-studies, the first goal of this paper is to test if indeed decreasing access to forestry resources disproportionately affect women due to their persistent role of providing unpaid care work and perform collecting activities in rural households of the Global South. Particularly, we ask if an increase in net deforestation is associated with an increase in unpaid hours of domestic work performed by women in rural households of the Brazilian Amazonia, controlling for income, household size, and other relevant variables.

If that hypothesis is confirmed, we can then ask: does the worsening of women's economic conditions—increasing time of unpaid care work and, therefore, decreasing time of leisure and paid activities—caused by deforestation incentives civil society organizations to take action in

regions that suffer a decrease on forestry resources? In other words, does deforestation agitates civil society organizations focused on gender equality, since women are disproportionately impacted by that phenomena?

Shandra *et al.* (2008) believe that both hypotheses are true and, further, sustain that women’s advocacy institutions not only take action when deforestation increases, but actually that their actions are affective and decrease deforestation. The authors describe for main channels through which that happens: (1) provide financial and technical assistance at the local level, that can be used for agroforestry projects, demarcating parks and promoting educational activities; (2) help stimulate social movements, that pressure governments and companies through protests, consumer boycotts, petitions and so on; (3) monitor activities of extractive industries, prevent the violation of legal obligations and use the media and international resources to generate accountability, which is one of the challenges for LMICs due to lack of budget and corruption; (4) conduct research and provide technical guidelines to improve the performance of corporations and increase the efficiency on monitoring extracting activities. The full mechanism through which WIOs can impact deforestation is summarized in Figure 1.

**Figure 1: Research question mechanism**



Source: author own elaboration

Despite sharing similar optimism about the power of collective action to change deforestation outcomes, our paper claims that such hypothesis is hard to be tested for several reasons. First and foremost, there's a circular causation on the mechanism, which requires complicated and quite arbitrary decisions about how long it would take for those civil society organization to identify a local deforestation issue, gather resources to move/open a center close to the location, and act to effectively decrease deforestation in a meaningful and measurable way. Further, datasets with information about the size, budget, and strategies of civil society organizations are not frequently available, and the presence of such institutions can be a result of self-selection bias—locations that are worried about gender equality and deforestation are welcoming to civil society organizations focused on those issues.<sup>1</sup>

Despite such shortcomings regarding civil society organizations, we claim that their presence is a better indicator of action and agitation around gender equality issues than identity-based variables. Most of the literature considering gender and natural resources is focused on identity (such as number of women representatives in political positions), which doesn't necessarily mean that gender equality demands are being represented. There are several historical (and contemporary) examples of women who didn't fight for or even believed in the importance of gender equality, while there are several men (and non-binary or agender individuals) who are important allies.

Our paper focuses on two parts of the mechanism described in Figure 1: do we observe an increase in unpaid working hours for rural women in the Brazilian Amazon when there are less

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<sup>1</sup> Shandra *et al.* (2008) proposes a cross-section ordinary least squares (OLS) regression with annual percentage of deforestation in natural forest area (1990-2005) as the dependent variable, and the “residualized” number of gender-equality focused NGOs that also explicitly focus on environmental issues and development (in 1990) as the independent variable of interest (“residualized” meaning the residual obtained by the regression of *per capita* WNGOs on the *per capita* ENGOs, as a way to avoid heteroskedasticity issues). We believe that such statistical techniques are not sophisticated enough to address the very complex task that the authors set to themselves.

forestry resources available (Part I) and, if we do, does that incentive civil society organizations focused on gender equality to start acting in those areas (Part II)? To introduce this important discussion, we exhibit an updated literature review, and first investigate if the long-run rate of forest cover per capita change from 1990 to 2018 is associated with a higher percentage of women fully dedicated to household activities in countries that share the Amazonian rainforest. At future steps, we will use data focused on the Brazilian Amazon to relate deforestation at the municipal level with hours of unpaid household work performed by rural women, and then with a possible change in the distance between such municipalities and a gender equality civil society organization.

## **2. Literature review**

All reliable international databases, such as the Food and Agricultural Organization (FAO), the World Bank (WB) and the United Nations (UN), are unanimous in showing the greater number of hours put by women in unpaid work dedicated to the household when compared to men, particularly for families in rural areas of LMICs. The literature presented by Shandra *et al.* (2008) indicate that those gender inequalities issues are deepened with deforestation due to less availability of firewood, which increases the amount of unpaid labor dedicated to the household (due to the greater distance traveled in order to collect the material) and decrease income opportunities, both through the direct effect of less firewood available for the production of tradable goods (food, pottery, alcohol) and the indirect effect of less hours available for those activities (Rawat, 2004; Joekees *et al.*, 1996; Koda, 2004).

The authors also argue that the decrease in firewood access uniquely affects the health and nutrition conditions of women (and, to a lesser extent, of the entire household) through various

mechanisms, mostly due to the use of alternative fuel sources used when firewood is not available. Maskey (2005) and Cecelski (1985) show that cattle dung and crop residues are the most common substitutes, preventing those natural fertilizers to be used in subsistence crops – which are mostly worked by women – and decreasing productivity, with important effects on food availability (Dankelman & Davidson, 1988). Further, the smoke produced by those materials is more toxic than fuelwood (Katz & Monk, 1993), which is associated with increasing pulmonary disease and chronic respiratory infections (Dankelman & Davidson, 1988). Anker (1997) also points out that the greater distances traveled with heavy firewood are associated increasing levels of spine damage, pregnancy complications, and maternal mortality. And a rich literature on study cases throughout LMICs associates the lack of firewood with the production of less and less nutritious food (Buckingham-Hatfield, 2000; Agarwal, 1992; Santow, 1995), which is associated with higher levels of anemia and pregnancy complications (Dyches & Rushing, 1996; Shen & Williamson, 1999).

Not all impacts of deforestation are felt through the availability of firewood, however. Deforestation itself is associated with soil erosion and desertification, which negatively impacts the productivity of both subsistence and commercial crops (Rudel, 2005). Forests also provide other raw materials that are used for subsistence and income motives; particularly, such resources are used by women to produce handicrafts that frequently acquire more value added than other female-intensive tradable goods, so deforestation also lessens opportunities for women to pursue resource-based alternative livelihoods (Blackden & Wodon, 2006; Katz & Monk, 1993; Giannecchini *et al.*, 2007; Dovie *et al.*, 2004).

As we can see, the disproportionate gendered impact of deforestation is well documented, which gives rise to an increasing number of studies exploring how women's movements react to

environmental degradation. Microeconomic researches across the world are consistent in showing that women are more aware and concern with environmental issues (Pearson *et al.*, 2017), while regional study cases stress that women are becoming increasingly involved in dealing with deforestation impacts, mainly through NGOs and grassroots organizations (Rudel, 2005; Guha, 2000; Shiva, 1988; Aye, 2018; Oedl-Wieser, 2017). The few cross-national studies available relate higher levels of women political participation with outcomes such as higher probability of ratifying environmental treaties, and higher number and endorsement of environmental legislation (Norgaard & York, 2005; Salahodjaev & Jarilkapova, 2020; Ramstetter & Habersahck, 2019) – which are highly relevant, but still focused on identity (meaning if the social actors identify as women) instead of advocacy (i.e. if they are, in fact, pushing forward the gender equality and women’s rights agenda).

Such literature also face a lot of criticism, mostly due to the struggles associated with data and modeling strategies. The first issue is the problem of self-selection bias: countries in which the presence of IOs is higher and their actions are more able to impact deforestation (through any of the channels described in the Introduction of this paper) are likely countries with better institutional quality and governance, which are themselves variables associated with more efficient environmental policies, so better governance leads both to increasing number of IOs and less deforestation (Wehkamp *et al.*, 2018; Geist & Lambin, 2002; Culas, 2007; Mendelsohn, 1994). Given that there is no dataset with details of IOs and relevant local organizations such as number of members and supporters per country, financial information, or number of actions performed by year – not at the country level, much less a cross-country database that would make such information comparable – the question if either the presence of those institutions is the factor

contributing to decreasing deforestation or just capturing some of the effects of better governance becomes tricky to answer.

Another important weakness in the literature is that the direction of causality between deforestation and presence of IOs is uncertain, as shown in Figure 1 above: increasing levels of deforestation should increase the number of organizations in a particular country; once present and acting, those same organizations should be capable of decreasing the levels of deforestation, but the timeframe in which those actions take place is hard to measure. The problem of time related variables in environmental economics literature is a controversial topic, since separating the effect of the independent variable from time effects requires the imposition of restrictions on the controls that might drive the shape of the relationship between the dependent and independent variables, which is particularly problematic given the discussion of the Environmental Kuznets Curve (EKC) for deforestation, that assumes an inverted U-shaped relationship (Vollebergh *et al.*, 2009; Assa, 2021). Studies about the EKC may also suffer from econometric weaknesses due to the spurious regression problems associated with the presence of unit roots (Wagner, 2008).

Our attempt to dialogue with the literature while acknowledging those important critiques is to propose an empirical analysis to investigate if deforestation is associated with increasing unpaid working hours in domestic work for women (controlling for income, household size, and other important variables), and if deforestation increases the presence of gender equality focused civil society organizations in the region. By focusing on those specific chains of the mechanism, we reduce the self-selection bias, and focus on the intention of those institutions, leaving the problem of their actual capacity for affecting deforestation (which also depends on governance and institutions and requires at least approximation of their resources) for further studies on this subject.



### 3. Data and modeling approach

To get an overview of how deforestation looks like in the Amazonia region and if it's associated at all with women living conditions (and unpaid care work, specifically), we first run some national-level regressions using three different dependent variables: percentage of rural women who are not working nor studying (meaning, women who are fully dedicated to unpaid activities including subsistence production), percentage of rural women who are fully dedicated to household activities, and the rural women/men income ratio. We use data from the United Nations, the World Bank, and the Food and Agriculture Organization for 5 countries (Bolivia, Brazil, Colombia, Ecuador, and Peru), during the years of 2000-2019. Our independent variable of interest is net deforestation, as measured by the annual change on forestry coverage per capita of rural population, and we control for some household characteristics.

**Table 1. Descriptive statistics.**

	<b>N</b>	<b>Max</b>	<b>Min</b>	<b>Mean</b>	<b>SD</b>
%RW without income	88	71.9	24.2	41.1761	11.2424
%RW HH main activity	74	54.5	13.1	27.2122	12.2889
R Income Ratio	88	86.8	55.1	66.908	6.5058
Deforestation per capita	95	1.6052	.1476	.467	.3757
%RHH safe water	96	75.9	14	42.0167	16.6597
%RHH sanitation	85	88.8	6	40.1412	23.6766
%RHH electricity	85	98.6	23	75.3047	22.6524
%RHH poverty	88	87	26.8	51.4557	14.93
%RHH extreme poverty	88	73.3	7.7	26.575	15.0574
RHH size	88	4.6	3.1	3.8523	.3974
RHH size squared	88	21.16	9.61	14.9961	3.0514
RW/RM years of education	88	1.1833	.5686	.9008	.2002

We expect the coefficient of the first two regressions to be positive, i.e., an increase in deforestation per capita (decrease in forest coverage per capita of rural population) should increase the percentage of rural women without income and not studying, and increase the percentage of

rural women that have household duties as their main activity. About the income ratio, the relationship is more complicated. Deforestation might decrease the income of women, but since our panel is characterized by strong male-breadwinner households (meaning most households are structured so that the substantial majority of the household income is provided by men) it would make sense for deforestation to increase the gender income ratio by substantially decreasing the denominator. Indeed, a positive coefficient in this third regression reinforces the idea that more unpaid household or subsistence activities dedication from women are not a result of more income from men (and therefore less pressure for women to perform paid work), but indeed a necessary outcome of less forestry resources.

Due to the presence of heteroskedasticity in our first and third regressions, we use a Feasible Generalized Least Squares approach. For Model II, we just use a robust Ordinary Least Squares (OLS) regression. All OLS regressions have country and time fixed effects. Since we don't know how long it would take for a decrease in forestry resources to impact the household, we also run the regressions with a one year and a two year lag. The results are showed below.

**Table 2. Results of Models I, II and III.**

Model I: %RW not studying without income					
	(1) Full	(2) Robust	(3) FGLS	(4) FGLS 1Y Lag	(5) FGLS 2Y Lag
Deforestation per capita	-31.07*** (7.195)	-31.07* (7.451)	9.801** (3.219)		
1Y Lag Deforest pc				9.456** (3.389)	
2Y Lag Deforest pc					8.481* (3.546)
%RHH water	-0.151 (0.107)	-0.151 (0.0846)	-0.118* (0.0513)	-0.121* (0.0549)	-0.103 (0.0577)
%RHH sanitation	-0.0146 (0.0474)	-0.0146 (0.0304)	0.00136 (0.0375)	-0.00140 (0.0390)	-0.000954 (0.0425)
%RHH electricity	-0.0201 (0.0592)	-0.0201 (0.0907)	-0.115* (0.0453)	-0.105* (0.0481)	-0.0895 (0.0508)
%RHH poverty	-0.654*** (0.183)	-0.654* (0.216)	0.0454 (0.145)	0.00900 (0.152)	-0.000161 (0.157)
%RHH extreme poverty	0.999*** (0.169)	0.999** (0.176)	0.431*** (0.112)	0.461*** (0.117)	0.484*** (0.124)
RHH size	200.6*** (33.44)	200.6** (31.46)	46.91* (20.05)	44.14* (20.93)	43.22* (21.88)
RHH size squared	-25.53*** (4.530)	-25.53** (4.572)	-4.536 (2.670)	-4.132 (2.808)	-4.024 (2.950)
RW/RM education	-6.950 (22.59)	-6.950 (20.97)	38.19*** (6.326)	37.13*** (6.626)	33.83*** (6.784)
N	100	100	100	95	90
Country FE	Yes	Yes	No	No	No
Time FE	Yes	Yes	No	No	No
Robust	No	Yes	No	No	No

Standard errors in parentheses  
\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Model II: %RW HH main activity

	(1) Full	(2) Robust	(3) 1Lag	(4) 2Lag
Deforestation per capita	4.146 (6.096)	4.146 (7.640)		
1Y Lag Deforest pc			5.931 (6.501)	
2Y Lag Deforest pc				9.128 (6.958)
%RHH water	-0.0936 (0.0903)	-0.0936 (0.0527)	-0.0929 (0.0528)	-0.0869 (0.0569)
%RHH sanitation	0.121** (0.0402)	0.121 (0.0872)	0.110 (0.0770)	0.0987 (0.0615)
%RHH electricity	-0.00745 (0.0502)	-0.00745 (0.0782)	0.0283 (0.0732)	0.0945 (0.0589)
%RHH poverty	-0.0516 (0.155)	-0.0516 (0.256)	0.0167 (0.255)	0.114 (0.241)
%RHH extreme poverty	0.0773 (0.143)	0.0773 (0.284)	0.0610 (0.306)	0.0636 (0.308)
RHH size	-47.52 (28.34)	-47.52 (36.43)	-50.37 (31.41)	-52.97 (30.71)
RHH size squared	4.467 (3.839)	4.467 (4.966)	4.976 (4.300)	5.511 (4.197)
RW/RM education	1.404 (19.14)	1.404 (20.67)	2.385 (16.66)	5.734 (13.89)
N	100	100	95	90
Country FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Robust	No	Yes	Yes	Yes

Standard errors in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Model III: income ratio					
	(1)	(2)	(3)	(4)	(5)
	Full	Robust	FGLS	FGLS 1Y Lag	FGLS 2Y Lag
Deforestation per capita	-20.21 (10.64)	-20.21** (2.785)	10.81** (4.088)		
1Y Lag Deforest pc				8.659* (4.112)	
2Y Lag Deforest pc					5.868 (4.041)
%RHH water	0.111 (0.158)	0.111 (0.120)	0.0883 (0.0651)	0.116 (0.0666)	0.171** (0.0658)
%RHH sanitation	0.297*** (0.0702)	0.297 (0.120)	0.171*** (0.0477)	0.153** (0.0473)	0.137** (0.0485)
%RHH electricity	-0.0891 (0.0876)	-0.0891 (0.104)	-0.0922 (0.0576)	-0.0578 (0.0584)	-0.0194 (0.0579)
%RHH poverty	-0.950*** (0.271)	-0.950* (0.236)	-0.295 (0.184)	-0.204 (0.184)	-0.0816 (0.178)
%RHH extreme poverty	0.771** (0.250)	0.771* (0.234)	0.250 (0.142)	0.187 (0.142)	0.120 (0.141)
RHH size	-16.60 (49.47)	-16.60 (44.04)	-119.1*** (25.47)	-106.8*** (25.39)	-86.92*** (24.93)
RHH size squared	0.786 (6.701)	0.786 (6.325)	16.08*** (3.390)	14.27*** (3.406)	11.41*** (3.361)
RW/RM education	49.14 (33.41)	49.14 (24.15)	17.29* (8.034)	12.38 (8.039)	5.242 (7.729)
N	100	100	100	95	90
Country FE	Yes	Yes	No	No	No
Time FE	Yes	Yes	No	No	No
Robust	No	Yes	No	No	No

Standard errors in parentheses  
\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

The preliminary results indicate that our hypothesis makes sense at the national level: deforestation does have impacts for women in terms of unpaid household work. However, since those countries have rural populations that are not residing on the Amazon, and our mechanism indicates a much more local impact of the decrease of forestry resources, less aggregated data is necessary. Further, a more precise way to measure the impact of net deforestation is through the observation of the number of hours dedicated to unpaid household work by women. Deforestation data as reported in the Food and Agriculture Organization is also not the most reliable—there’s a bias to underscore how much deforestation actually occurred, since countries have a commitment

with the United Nations and other institutions to decrease deforestation and get financially compensated (through the Amazon Fund, for example) when they achieve it. Finally, the definition of rural versus urban in some census is not very reliable either. In Brazil, for example, municipalities have an incentive to declare their residents as part of the urban territory, since the land tax on urban property is smaller when compared to rural property. According to the dataset used above, only 16% of the population residing in the Brazilian Amazon is considered rural, while the *Instituto Brasileiro de Geografia e Estatística* (the official statistical entity of Brazil) argues that at least 25% of those residents directly rely on forestry resources and live in rural areas.

#### **4. Further research**

To address those issues, we decided to focus on the Brazilian Amazon—the largest portion of the rainforest—using city-level data. We rely on satellite data on net deforestation by municipality in the Brazilian Legal Amazon captured by LANDSAT satellites and synthesized by the PRODES project. For each year of PRODES mapping, they generate mosaics in geotiff format where the original spatial resolution is 30x30 meters. After generating the annual mosaics, a TerraView System function was used to outline the pixels of each class mapped by PRODES (deforestation, forest, non-forest, hydrography and cloud) within each municipality; then, this number of pixels per municipality was transformed into an area in Km<sup>2</sup>, providing a significantly more reliable and precise dataset for deforestation.

To define which of those municipalities are indeed rural, we use the work of Lobão and Staduto (2019), which classify each city as either “essentially rural” (85% of the municipalities in our sample), “relatively rural”, and “urban”. The authors use a territorial approach, applying the guidelines for urban-rural differentiation established by the Organization for Economic Cooperation

and Development (OECD) for the Brazilian context, adapting the pertinent population density and political-administrative criteria.

The change in women unpaid household work, as defined by numbers of hours of unpaid domestic work performed by women, is calculated by municipality using the *Pesquisa Nacional por Amostra de Domicílios – Contínua* (PNAD-C). Such survey allows us to know if the respondent is the women herself and, if not, what's the gender of the respondent, which permits the observation of possible overestimation or underestimation bias (for example, the possibility of unpaid household work being systematically underreported in terms of hours when the respondent is a man). It also has data on the main cooking fuel of the household (if butane gas, firewood, electrical oven/stove, or something else), which serves as a proxy for dependence on firewood. Merging the PNAD-C and PRODES datasets, and using the Lobão and Staduto methodology, we end up with annual data of 588 municipalities, for the 2001-2021 period.

To investigate the second part of our mechanism (if such hypothesized increase in unpaid household hours by women caused by deforestation do translate in a higher presence of civil society organizations concerned with gender equality), we use the same municipal-level deforestation data as a dependent variable and calculate the distance of that municipality to a civil society organization that declares gender equality as one of their goals, using the address and Sustainable Development Goal declared by the organization in the *Mapa das Organizações da Sociedade Civil* dataset. We are interested in discovering if higher deforestation is associated with a gender-equality focused civil society organization opening closer to that location in the next year, two year, or five-year period. Since part of such dataset must be build manually, we still can't precise the number of datapoints available for this analysis.

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