Correlates of Deforestation in Turkey: Evidence from High-Resolution Satellite Data

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Abstract

During the last decade, environmental issues have gained saliency in Turkish politics, especially after the Gezi Park demonstrations. However, no systemic empirical evidence exists to inform us of the relationship between politics and deforestation in Turkey. This paper combines possible major drivers –political, economic, and climatic–of deforestation in Turkey with high-resolution satellite data on deforestation to perform a systemic empirical analysis. The results show that districts with Justice and Development Party (AKP) mayors have higher deforestation —around a combined area of forty-two football pitches on average in a given district. Similarly, increased mining activities and newly built dams positively correlate with deforestation.

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1 Introduction

Environmental issues have increasingly become one of the most contentious topics in Turkish politics over the last decade. These issues have gained saliency, especially after the Gezi Park demonstrations, which began in order to defend the last green area in Taksim, İstanbul. Despite this increased attention, no systemic empirical evidence exists to inform us about the correlates of deforestation. In the absence of empirical evidence, while environmental resistance movements blame the government for destroying forests for infrastructural and energy projects and mining activities, the government and President Erdoğan deny the allegations. On the contrary, Erdoğan even claims that his government planted "4.5 billion trees" under his leadership.[1] As a result, we are unable to adjudicate between these different claims, despite the availability of high-resolution satellite data on forests.

Although the desire to grow economically at the expense of the environment has been the central theme in every political movement in Turkey (Arsel 2016), Turkey's "competitive authoritarian" regime (Esen and Gumuscu 2016; Levitsky and Way 2010) poses two distinct threats to the environment. While the competitive (though unfair) nature of elections can make politicians more willing to sacrifice trees for votes (Cisneros Tersitsch et al. 2020; Pailler 2018), the absence of effective horizontal checks on the executive branch, such as an independent judiciary, creates amenable conditions for political rent creation (Acemoglu et al. 2013; Persson et al. 1997), in which forests are used for corrupt practices.

We know that forests have been destroyed throughout the last few decades in Turkey[2], no study has so far empirically investigated the impacts of both central and local governments' extractivist policies in various sectors, such as mining, energy, and tourism. In the absence of any systemic empirical analyses, we do not know how much each factor correlates with deforestation in the country. That is why this paper studies the correlates of deforestation using high-resolution Landsat data. Deforestation in this context is defined as "as a stand-replacement disturbance or the complete removal of tree cover canopy at the Landsat pixel scale" (Hansen et al. 2013, p. 850). This paper brings together possible major drivers –political, economic, and climatic–of deforestation from Turkey and conducts a systemic empirical analysis. Using high-resolution satellite data has various advantages over administrative data on forest coverage. First, the General Directorate of Forestry (Orman Genel Müdürlüğü) does not release annual data on forests (Türkiye Ormancılar Derneği 2019, p. 14). The Directorate works on a forested area of around two million hectares each year, taking ten years to cover the whole country. The latest data on forested areas in certain regions is twenty years old (Türkiye Ormancılar Derneği 2019). Therefore, it is not possible to use official data on forests to understand the drivers of deforestation since the data comes with severe lag. Moreover, the released data are at the province level and do not allow fine-granular analysis at smaller geographical units. Third, data transparency and quality become serious issues, especially in democratically backsliding

[1] See İletişim Başkanlığı (2019).

[2] See, for instance, Global Forest Watch (n.d.).

countries like Turkey, since information manipulation is one of the primary ways to maintain legitimacy (Guriev and Treisman 2019).

However, high-resolution satellite data allows us to track changes in forested areas at fine-granular levels (thirty-meter resolution) annually. More importantly, data quality is not impacted by political considerations. Last, defining deforestation with respect to the Landsat pixel scale means that the measurement does not suffer from different definitions of forest,[3] making the data comparable across time and space.

By combining this satellite data with various data sources on possible drivers, I show that three factors consistently correlate with deforestation in Turkey: local Justice and Development Party (henceforth, *AKP*) rule, new hydropower plants, and mining activities. Having a district (*ilçe*) whose municipalities are all governed by AKP mayor(s)[4] correlates with higher tree loss by around forty-two football pitches in a given district for each election period. Similarly, a district has higher tree loss by about 253 football pitches if the share of mining enterprises increases from none to 7%.[5] Building new hydropower plants is also correlated with higher tree loss: Going from one new hydropower plant to seven new plants, which is the maximum observed in the sample, is positively associated with tree loss by around 120 football pitches in that district.

This paper makes several contributions. It provides the first empirical evidence on the correlates of deforestation in Turkey by paying specific attention to politics. Therefore, it contributes to the empirical political science and economics literature on deforestation (Burgess et al. 2012; Cisneros Tersitsch et al. 2020; Pailler 2018; Sanford 2021). It is also linked with scholarly works that analyze the impact of local governments on deforestation (Cisneros Tersitsch et al. 2020; Lemos and Agrawal 2006; Ribot et al. 2006). Second, it gives credence to the argument that local governments in Turkey are important actors despite their limited role in the design of environmental policies (Orhan 2013). Last, quantifying impacts allows us to compare the adverse impacts of various industries.

The structure of the paper is as follows: The following section focuses on the correlates of deforestation within the context of Turkey. The next section introduces the empirical strategy and explains the data sources and how variables are constructed. Section 4 presents the results, and section 5 concludes.

2 Correlates of Deforestation

Since the foundation of the republic, the idea of development through rapid economic growth is not challenged by any political movement (Arsel 2016). Despite differences in other dimensions (economic ideology and progressive/conservative values), political parties in Turkey have always supported developmental projects irrespective of their ideology (Paker et al. 2013; Turhan et al. 2016). However, the desire to grow economically at

[3]For instance, the United Nations Framework Convention on Climate Change defines forests differently than the Food and Agriculture Organization. See: Tolunay (2017)

[4]Note that municipalities are nested within districts.

[5]Küre district in Kastamonu province has the maximum level of mining activity observed in the data, which is 7.2%.

the expense of the environment has increased dramatically with the AKP governments (Akbulut and Adaman 2013), both through the actions/policies of the central and local AKP governments. This became possible with the AKP's increasing authoritarianism since it makes it easier for central and local AKP governments to ignore environmental protection for economic growth and rent creation.

However, how rising authoritarianism can impact the environment is theoretically not clear. Although politics is recognized as an essential contributor to environmental issues in general and deforestation in particular, disagreement exists in how it affects. It is known that democracies provide more welfare to their citizens than non-democracies (Przeworski et al. 2000), because democracy forces the leaders to heed the needs of the masses (Mill 2004 [1861]) and makes political leaders more responsive to the popular demands for environmental protection (Barrett and Graddy 2000; Farzin and Bond 2006). Therefore, it is theoretically plausible that deforestation should be more severe in authoritarian countries.

This logic indeed drives local and global environmental organizations to focus on decentralization and community-based forest management as an institutional reform to prevent tree loss (Klopp 2012, p. 352). By "democratizing" the environmental governance, decentralization aims to include locals, who are most likely to be affected by the destruction of forests, in decision-making processes.

However, others point out that the relationship between democracy and the environment is not that clear (Buitenzorgy and Mol 2011) and that democratization and local governance do not guarantee the prevention of tree loss. On the contrary, patronage politics causes further tree loss, especially in settings with competitive elections. Forests can be used as resources for political purposes to satisfy the private interests in exchange for votes (Klopp 2012). Re-election incentives make politicians more willing to sacrifice trees for votes (Cisneros Tersitsch et al. 2020; Pailler 2018), creating "political logging cycles" (Burgess et al. 2012). The recent evidence has shown that democratization can bring further deforestation, especially in weak democracies with highly competitive elections (Sanford 2021).

Turkey's regime is best characterized as "competitive authoritarian" (Esen and Gumuscu 2016; Levitsky and Way 2010). In these regimes, elections are still competitive despite being unfair.[6] I argue that the competitive authoritarian nature of the regime provides a setting that gets the environmentally damaging characteristics of both democratic and authoritarian regimes. On the one hand, re-election pressures do not fade away in competitive authoritarian regimes, unlike the fully authoritarian regimes. The electoral pressures coming from competitive elections make the government ignore the environment since protecting it does not pay off electorally in the short run.

At the same time, horizontal institutions of accountability such as the independent judiciary or civil society cannot effectively check the government for environmental regulations, unlike fully consolidated democracies. Moreover, the public cannot effectively check the government's rent-seeking behaviors with the politically cap-

[6]The government lost major provinces such as İstanbul and Ankara in March 2019 local elections, showing the competitive nature of the elections despite their unfairness.

tured media. This absence of checks and balances, as a result, brings about greater flexibility for both central and local AKP governments to cater to private interests at the expense of the environment.

As a result, the central government pursues a similar developmentalist logic compared to previous governments, albeit with a much-increased pace and without any input from the public (Özkaynak et al. 2020), due to the nature of the competitive authoritarian regime. In such an institutional setting, local AKP governments, in addition to the central government, gets more leeway to transfer forested lands to politically-connected business people for rent creation. Indeed, the evidence shows that private interests are more easily catered to over the last decade in Turkey (Gürakar-Çeviker 2016; Gürakar-Çeviker and Meyersson 2016). As a result, "unprecedented extractivist drive" (Adaman, Arsel, et al. 2022, p. 154) in various sectors such as mining, energy, and construction became possible, which brought significant environmental problems, including deforestation (Adaman and Akbulut 2021).

The energy sector is one of the primary sectors where we see the impacts of AKP's unprecedented modernist ambitions (Özkaynak et al. 2020). The AKP government started a series of legal changes that opened the electricity market to the private sector after they came to power (Eren 2018). The desire to reduce dependence on fossil fuels made hydroelectric power plants one of the favorite methods to produce electricity. As a result, the government aimed to construct dams in all major rivers by 2023, causing an immediate increase in the number of newly built small-scale hydroelectric power plants in the country (Eren 2018). The decision to dramatically expand the number of power plants was not taken with active public participation, and their impacts on the local ecosystems and communities have been ignored (Özkaynak et al. 2020). At the same time, however, the energy production capacity increased threefold (Erensü 2018). Although these small-scale hydroelectric plants are believed to have minimal impact on the environment, their extensive utilization means that their environmental impacts are no different than large-scale dams (T. Abbasi and S. Abbasi 2011; Pang et al. 2015). Unsurprisingly, their adverse effects on the environment, including, but not limited to, tree loss, created opposition, especially from the local communities (Sayan 2019; Sayan and Kibaroglu 2016).

Another critical sector that is dramatically impacted by the AKP's extractivist desire is mining. The government subcontracted mining operations to the private sector in many settings to increase production (Adaman, Arsel, et al. 2022). In addition to increasing environmental costs, this practice also brought about tragic incidents such as the Soma mining disaster.

By using remote sensing methods, some previous studies have already shown adverse environmental impacts of mining operations (Gül et al. 2019). Even when such mining operations stop, abandoned open-pit mines continue to pollute the environment (Yucel and Baba 2013). In Soma, for instance, where 31% of the domestic lignite production takes place, places around the mining areas witness water and air pollution, lower agricultural yield, and deforestation (Karadag 2012).

Tourism is another critical industry affected by such extractivist desire due to its links with the construction sector. According to the World Tourism Barometer, Turkey is the sixth most visited country globally (UNWTO

2020). However, while Turkey's tourism policy aimed to increase the number of tourists, the environment has not been the priority, resulting in the conversion of significant forested lands into tourism-related facilities such as hotels (Kuvan 2010). Especially after wildfires, the possibility of turning burned forested areas into luxury holiday resorts and hotels has been one of the primary concerns in the opposition media.[7]

In addition to the central government's extractivist drive in mining, energy, and construction, the competitive authoritarianism also makes local AKP governments prioritize economic growth and rent creation at the expense of the environment. Although political patronage has always been a historical problem for Turkey (Heper and Keyman 1998), the AKP government made it the basis of the competitive authoritarian regime (Esen and Gumuscu 2018, p. 351). Local governments are not the primary actors in the design of environmental policies; however, they are important actors when it comes to the execution of these policies (Orhan 2013). Moreover, local governments in Turkey play direct roles in preserving green areas in urban spaces since they are responsible for taking care of them within their jurisdiction. Both the municipal law (*5993 Sayılı Belediye Kanunu*) and the metropolitan municipal law (*5216 sayılı Büyükşehir Belediye Kanunu*) make clear that local governments are responsible for green areas (Toprak 2017). Moreover, local governments can directly affect tree cover within their boundaries due to their authority in city development plans. They can modify existing plans and create rents at the expense of the environment.

Last, some previous studies have argued that conflict between insurgent Kurdistan Workers Party (PKK) and the Turkish state forces can also increase deforestation (Gurses 2012; Van Etten et al. 2008). These studies argue that state forces' deliberate attempts to limit the insurgents' capacity to wage war can also bring about deforestation. That is why I also analyze the impact of conflicts on deforestation in the analyses below.

In short, I expect that the AKP's government extractivist drive in mining, energy, and tourism sectors should significantly increase deforestation in the country. Moreover, in the absence of adequate checks, local AKP governments should be more likely to pursue policies to cater to private interests that cause further environmental problems, including deforestation.

3 Empirical strategy and Data

Analyzing correlates of deforestation requires data collection from various sources. I rely on high-resolution spatial data to construct the dependent variable, *tree loss*, which comes from Hansen et al. (2013). They use Landsat data to compile high-resolution global maps of tree cover change. The satellites use remote sensing technology to collect high-resolution reflectance characteristics of the ground. Each pixel reflects lights in a different way. For instance, water reflects lights differently than forests. Based on these reflectance characteristics, each pixel is classified (Iverson et al. 1989).

[7] See Ünker (2021).

Since this data is high resolution (around thirty meters), I aggregated them at the district (*ilçe*) level. In particular, I calculated the percentage of tree loss of the total net land.[8] That is, for each district and year, I first counted the number of pixels–each is around 625 m^2–that witnessed tree loss.[9] Then, I divided this by the total number of pixels (the total net land) and multiplied by 100 to get the percentage of tree loss per year for each district. I use this variable, *Total % Tree Loss*, as my main dependent variable in the analysis.

To show the fine granularity of the data, I created an İstanbul map in which I highlighted pixels that witnessed tree loss in different periods. As we can see in Figure 1 below, the new airport's damage to tree coverage is immediately apparent. One can also visually track the damage caused by the newly built highway for the third bridge. I construct *Total % Tree Loss* by essentially tracking these pixels.

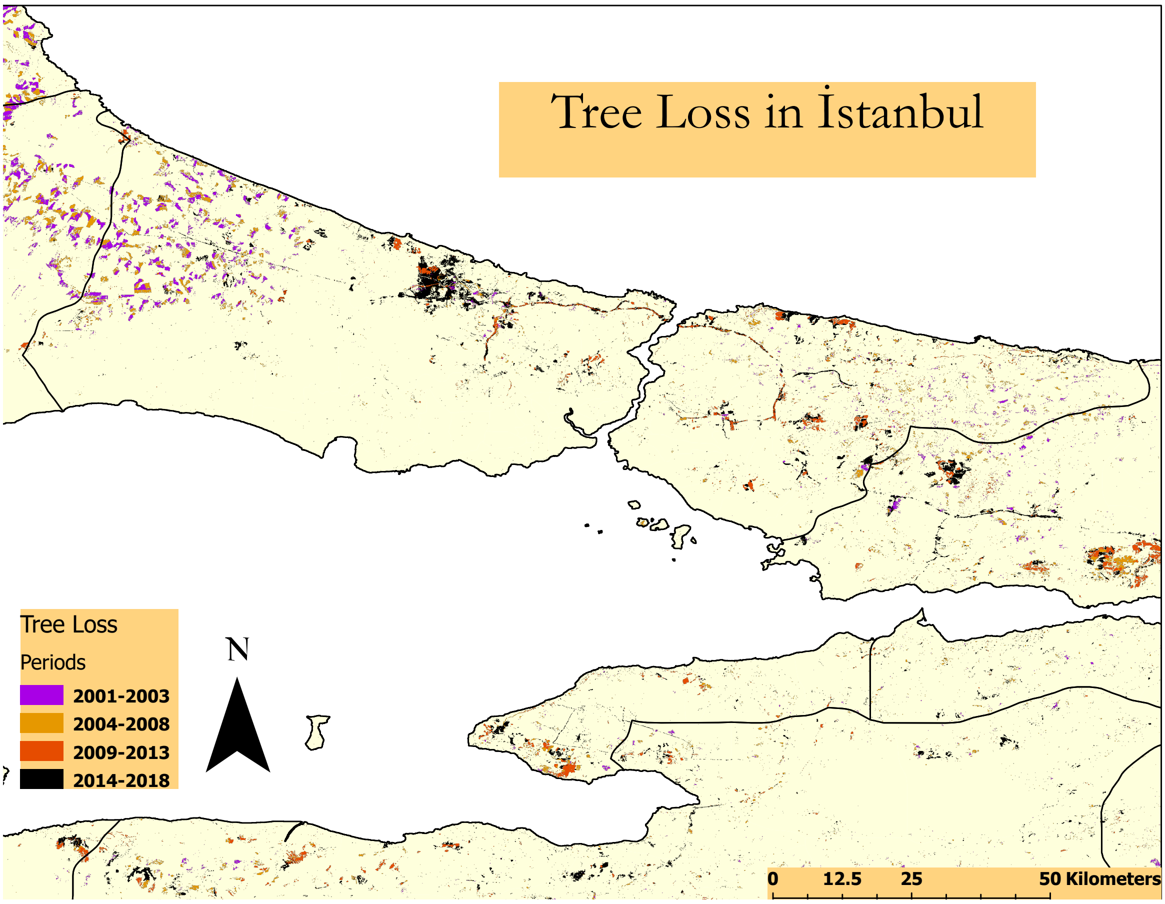

Figure 1: Tree loss in İstanbul and its surroundings in different time periods

Based on the discussion in the previous section, I identified various important variables that can correlate with deforestation. First, to identify local governments' impact on deforestation, I created a measure to proxy for the AKP's local rule intensity. For each election period, I identify the mayors' partisan affiliations. Since municipalities are nested within districts, I used a weighted ratio variable to measure the AKP local rule's intensity. In particular, I divided the number of voters that live under AKP municipalities by the total number of voters within

[8] It is "net" since I excluded permanent water bodies such as rivers, lakes, reservoirs from the calculations.

[9] Although the resolution is thirty meters, this is the value you would get at the Equator. It gets smaller as one moves towards the poles, and the resolution is around twenty-five meters in Turkey.

each district. This weighted ratio variable takes into account differences in municipality sizes. For instance, in a district with two municipalities, if the AKP mayor is running a municipality twice as large as the non-AKP municipality, the AKP local rule variable will be $\frac{2}{3}$ in this weighted specification, as opposed to $\frac{1}{2}$. Although I use this weighted AKP local rule variable as my independent variable in the analyses below, I also show that the results are robust to different specifications. Also, note that each district has exactly one municipality in provinces with metropolitan status after the change in the Metropolitan Municipal Law in 2014.

To measure the impact of hydroelectric plants, I created an original dataset on the new hydropower plants built in the analyzed period. I used various sources such as the online energy atlas[10] and various government reports[11] to determine the date and the location of each new hydropower plant built. As a result, I managed to identify 502 hydropower plants built in the analyzed period (2004-2018). Since this is a count variable, I log-transformed it before using it in the analyses and created *No. of New Hydropower Plants (log)* variable.[12]

For the mining sector, I use data from the Turkish Statistical Institute's Workplace survey, which was last conducted in 2002, and create the *Mining Share* variable, defined as the ratio of the number of workplaces in the mining sector over the total number of workplaces in a given district. Given that the Mining law has changed in 2004, the numbers from 2002 are mostly underestimating the current mining practices. Although this data is not up-to-date, it gives us a good baseline to account for differences across mining practices.

I use a dummy variable for the tourism sector that takes the value one if the district is on the Mediterranean or Aegean shores. To the extent that tourism affects deforestation adversely, we should see that these coastal districts lose more trees than the rest of the country.

I also use an extensive set of control variables that might correlate with deforestation. For instance, I use two variables to control general economic activities in districts. Previous studies have shown that population pressures and economic activities increase deforestation (Geist and Lambin 2002; Günşen and Atmiş 2019; Tolunay 2017). Therefore, we should expect higher tree loss in places that witness higher economic activity and population growth. The first measure is *Nightlight Difference*, which captures changes in economic activity in a given district. The literature has shown that nightlights are a good proxy for economic activities, and many empirical studies employed nightlight data to proxy for economic growth in cases where official statistics do not exist or are not reliable (Düşündere Taşöz 2019; Henderson et al. 2012; Hu and Yao 2019). Since the nightlight data series changed after 2013,[13] I standardized the nightlight values within each period to make them comparable across different periods. Then, I calculated their difference, and I used this differenced variable in the regressions to

[10]See Enerji Atlası (n.d.)

[11]I used the application results published by the Energy Market Regulatory Authority each year as they support hydropower plants as part of the mechanism to support renewable energy sources.

[12]No. of New Dams (log) = log(No. of New Dams +1)

[13]National Centers for Environmental Information (NOAA) produced DMSP-OLS Nighttime Lights Time Series for the period between 1992-2013. After 2013, higher-quality data (VIRRS) was supplied by NASA and NOAA's Suomi National Polar Partnership (SNPP) satellite.

proxy for economic growth. I also created the *Average Population Growth* variable since population growth can also cause increases in tree loss.

Since previous literature has also shown that conflict can also cause tree loss because of fires, I counted the number of conflicts that took place in Turkey between 2004 and 2018 using UCDP Georeferenced Event Dataset (Sundberg and Melander 2013). This dataset includes information about the location of conflicts worldwide. Using this location information, I counted the number of conflicts for each district in each period. I log-transformed this variable as well before using it in the analyses.[14]

I also control for climatic factors that can explain tree loss in certain regions in three ways. First, all model specifications below include province dummies (province fixed effect). This makes sure that we are only comparing provinces within themselves, and we are not comparing across provinces. Hence, fixed-effect models ensure that we are not comparing, say, Artvin, a province on the Black Sea coast with high forest area, with Yozgat, a province without significant green spaces. Province fixed effect also absorbs any uncontrolled time-invariant heterogeneity across provinces that could explain tree loss differences. Second, I use high-resolution temperature and precipitation data, which is available from 1960 at a monthly level for the whole world with around twenty km spatial resolution (Fick and Hijmans 2017). Using these monthly data, I constructed the average temperature range (maximum-minimum temperature in Celcius), and average precipitation (in mm) for every district. To further control for baseline differences in terms of tree coverage across districts, I also control for baseline green share in certain specifications.

Lastly, I control for fires using high-resolution firing data from NASA.[15] It records every fire captured by the satellites, and I counted the total number of fires within each district across years. Similar to other count variables, I also log-transformed this variable before using it in the analyses.

Using this data, I constructed a panel dataset for each district for three election periods: 2004-2008, 2009-2013, and 2014-2018. I aggregated at the election period level because mayors are the same within an election period. Therefore, my unit of analysis is the district-election period. The descriptive statistics are presented in Table 1 below.

[14] No. of Conflicts (log) = log(No. of Conflicts +1)

[15] The data is available here: NASA (2021)

	Mean	Median	SD	Min	Max
AKP	0.56	0.78	0.44	0.00	1.00
Ave. Pop Growth	0.43	0.10	6.66	-76.31	179.52
Nightlight Diff.	-0.02	-0.00	0.07	-0.74	0.22
Mining Share	0.00	0.00	0.01	0.00	0.07
No. of New Dams (log)	0.10	0.00	0.30	0.00	2.08
No. of conflicts (log)	0.12	0.00	0.44	0.00	3.99
Coastal District	0.07	0.00	0.26	0.00	1.00
Total No. of Fires (log)	2.28	2.08	1.81	0.00	8.40
Average Temp. Range	11.13	11.37	1.58	6.77	15.66
Average Precipitation	55.46	54.04	15.39	24.06	153.63
Baseline Green (share)	0.19	0.07	0.24	0.00	0.94

Table 1: Descriptive statistics of all variables used in the analyses

Then, using this panel dataset, I estimated the following linear model:

$$TreeLoss_{it} = \gamma_1 AKP_{it} + \gamma_2 LogNewHydroPlants_{it} + \gamma_3 MiningShare_{it} + \mathbf{X}\beta + \alpha_j + \theta_t + \epsilon_{it}$$

where $TreeLoss_{it}$ is the percentage of tree loss for district i within the period t, $t \in \{2004 - 2008, 2009 - 2013, 2014 - 2018\}$. AKP_{it} is the share of AKP-controlled municipalities (weighted by voters) in a given district i for the period t, $LogNewHydroPlants_{it}$ and $MiningShare_{it}$ are the logged number of new hydro power plants built and the share of mining enterprises in a given district i for the period t, respectively. $\mathbf{X}$ is the set of other covariates as summarized above. α_j is the set of province dummies (province fixed effect), and θ_t is the set of period dummies (time fixed effect).[16]

4 Results

Before presenting the main results, we can see how tree loss geographically varies across districts. To see that, I created the following map below. It shows that especially coastal districts witnessed higher tree loss in these years while Central Anatolian districts have lower tree loss. Of course, this is partly driven by the weak tree cover in Central Anatolia in the first place. That being said, however, Eastern Black Sea districts seem to perform slightly better than Mediterranean and Aegean districts despite having dense tree cover.

[16]Note that although I use province fixed effects in all specifications, I only use time fixed effects in some specifications to show that the results are robust to alternative specifications. Two-way fixed effects models are difficult to interpret because the model's estimates are a combination of variations in the over-time and cross-sectional effects (Kropko and Kubinec 2020). That is why the preferred model only uses province-level fixed effects. The standard errors are clustered at the district level for all specifications.

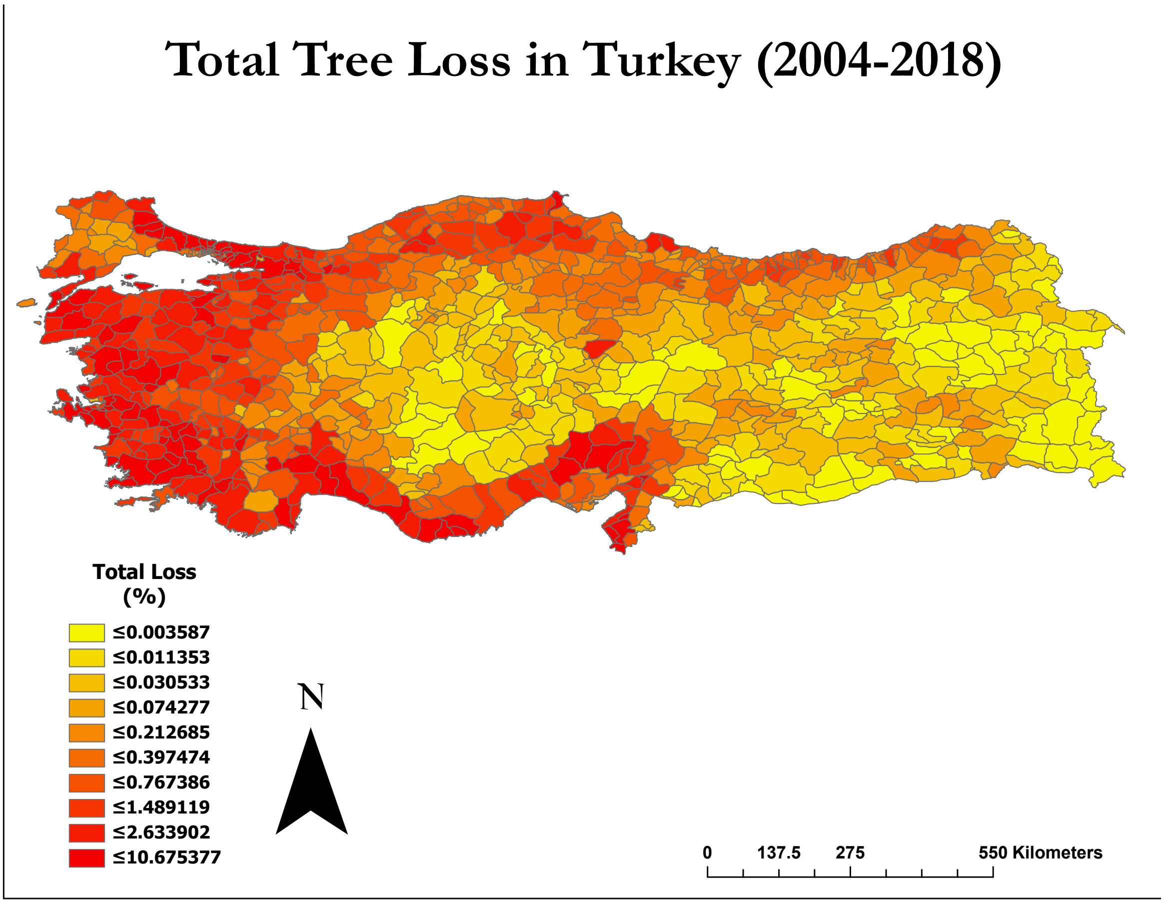

Figure 2: Total tree loss in Turkey

To systematically analyze the correlates of deforestation, I estimated the model specified above. The main results are presented in Table 2. To make sure that outliers do not drive the results, I also excluded extreme values based on the tree loss distribution.[17] In each model, I introduce a new set of variables. All models include every primary variable of interest: AKP rule, average population growth, nightlight difference, mining share, number of new hydropower plants, and number of conflicts. I also add geographic (coastal district) and climatic variables (total number of fires, average temperature range, average precipitation, and baseline green share) in order. I control for baseline green areas in the last two models since regions with already poor green areas have fewer trees to lose in the first place. The last model also includes a period fixed effects to account for common shocks. Among all models, three variables are consistently correlated with deforestation in the expected directions: AKP rule, mining share, and the number of new dams.

First, the local AKP rule is positively associated with deforestation at the district level. Using Model 5, we see that one unit increase in local AKP rule, meaning going from a district with no AKP mayor to a district ruled only by AKP mayor(s), positively correlates with tree loss by around 0.35%. This is around 1/10 of the standard deviation of the outcome variable. Given the limited impact of local governments on environmental policy design, this is a substantively sizeable impact. This translates into around forty-two football pitches (or ap-

[17] I excluded observations greater than those at the 97.5th percentile and lower than 2.5th percentile of the tree loss distribution.

proximately 0.3 km^2). Since Model 5 uses data from 827 different districts (excluding outliers), a back-of-the-envelope calculation suggests that in a hypothetical scenario in which only AKP mayors rule in every municipality, there would be tree loss equivalent to a combined area of 35,000 football pitches in each election period. These results only compare the differential impact of local AKP rule on tree loss by comparing districts among each other. Therefore, they do not capture the effect of the central government. Since the central government's actions can affect tree cover in non-AKP municipalities as well, these results are underestimating the AKP's actual impact on the tree cover.

Turning to the central government's extractivist policies in mining, energy, and tourism, we see that the mining share variable is positively associated with deforestation, although this variable is statistically significant only at the 10% level in the preferred specification (model 5). In the sample, many districts, such as Çanakkale-Bozcaada, Adana-Feke, and Bolu-Gerede, have zero shares of mining enterprises in 2002 while the maximum mining share is in Kastamonu-Küre (7.2%). Holding everything else constant, going from minimum (0) to maximum value (0.072) of mining share increases tree loss by around 0.21% (0.072×2.898). This suggests that going from a district with no mining activity to the maximum observed in the sample translates into tree loss equivalent to an area of 253 football pitches in a single district for each election period.

Similarly, building new hydropower plants positively correlates with tree loss. Going from one hydropower plant to the maximum observed in the sample (seven hydropower plants) translates into tree loss equivalent to an area of 120 football pitches in a single district for each election period. Being a coastal district by itself, on the other hand, is not correlated with tree loss.

	Dependent variable: Total % Tree Loss					
	1	2	3	4	5	6
AKP	0.033**	0.033**	0.033**	0.036**	0.035***	0.029**
	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)	(0.013)
Ave. Pop Growth	0.001	0.001	0.001	0.001	0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Nightlight Diff.	0.227**	0.227**	0.232**	0.317***	0.228**	0.085
	(0.100)	(0.100)	(0.101)	(0.107)	(0.098)	(0.108)
Mining Share	3.647***	3.650***	3.674***	3.512**	2.898*	2.951*
	(1.373)	(1.373)	(1.382)	(1.379)	(1.540)	(1.550)
No. of New Hydropower Plants (log)	0.066***	0.066***	0.065***	0.055***	0.051***	0.045**
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.019)
No. of Conflicts (log)	-0.013	-0.013	-0.015	-0.016	-0.017	-0.019*
	(0.013)	(0.013)	(0.013)	(0.013)	(0.011)	(0.011)
Coastal District		0.002	0.001	-0.016	0.025	0.017
		(0.069)	(0.070)	(0.069)	(0.064)	(0.064)
Total No. of Fires (log)			0.005	0.008	0.012**	0.012**
			(0.005)	(0.005)	(0.005)	(0.005)
Average Temp. Range				-0.008	0.034***	0.027**
				(0.010)	(0.011)	(0.011)
Average Precipitation				0.004***	0.002**	0.001
				(0.001)	(0.001)	(0.001)
Baseline Green (share)					0.769***	0.778***
					(0.095)	(0.096)
Num.Obs.	2572	2572	2572	2563	2563	2563
R2	0.479	0.479	0.480	0.492	0.539	0.546
R2 Adj.	0.461	0.461	0.461	0.474	0.522	0.529
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Period FE	No	No	No	No	No	Yes

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

Standard errors are clustered at the district level

Table 2: The correlates of tree loss in Turkey

Other variables are also correlated with tree loss in expected directions, although some are not statistically significant at conventional levels. For instance, nightlight difference, a proxy for economic activity, is positively correlated with tree loss, although it is not significant in the last model. Similarly, the coefficient for average population growth is positive but not significant. The number of conflicts does not seem to be correlated with deforestation either.

Among the climatic factors, we see that temperature range is positively correlated with deforestation, suggesting that places with higher variability in temperature are also more likely to witness tree loss. On the other hand, Average Precipitation is not correlated with tree loss once I include baseline green share and period fixed effects in the models (as in Model 6).

Last, we see that the total number of fires is positively correlated with tree loss as expected. The average number of fires per period is around sixty per district, while Mardin-Kızıltepe has the highest number with 4456 fires recorded for the period 2014-2019, which is a clear outlier. Holding everything else constant, going from one

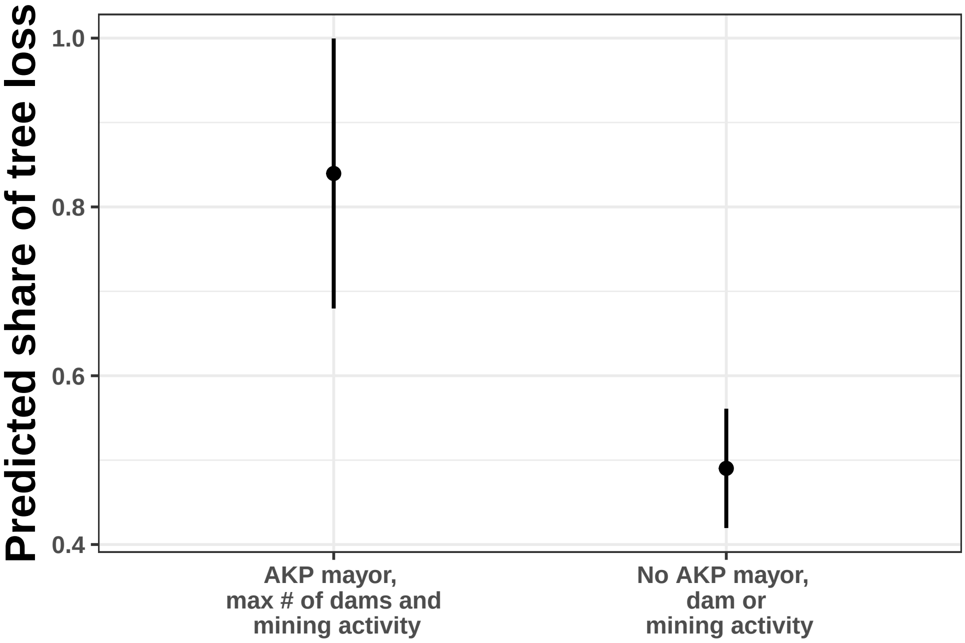

Figure 3: Predicted tree loss in two hypothetical districts

fire ($25th$ percentile) to thirty-three fires ($75th$ percentile) in a given district suggests an increase in tree loss by around 0.04% for a given district in each period. This translates into an area equivalent to fifty football pitches.

To further analyze how our main variables of interest, AKP rule, mining share, and new dams, jointly impact tree loss in the analyzed time frame, I use Model 5 in Table 2 to simulate expected tree loss under two hypothetical scenarios. The first hypothetical district has no AKP mayor and has no mining activity or new hydropower plant built during the analyzed period. The second hypothetical district's municipalities are all governed by AKP mayors, have the highest observed mining activity in the sample (7.2% of all enterprises in the district is mining), and witnessed the highest number of new hydropower plants built (seven). I hold all other variables at their central tendencies (mean or median) and calculate their predicted tree loss shares for these two hypothetical districts. The result is plotted in Figure 3. The predicted tree loss share in the first hypothetical district is 0.84% $[0.68, 0.99]$. In the second hypothetical district with no AKP mayor, a new dam, or mining activity, on the other hand, the predicted tree loss is 0.49% $[0.42, 0.56]$. These results imply that the combined effect of all these three variables brings about an average 71.4% increase in tree loss.

To show that the results are not model dependent, I conduct a series of robustness analyses. First, I repeat the analyses in Table 3 below by excluding three major cities (İstanbul, Ankara, İzmir) in the first two models. In the following two models, I exclude central districts from the sample and repeat the analyses. The results are substantively similar for our main variables of interest, alleviating the concerns that the results are purely driven by İstanbul, Ankara, İzmir or central districts in each province. In the Appendix section, I repeat the analyses by including the outliers into the sample, and the results are substantively similar (Table A1 in the Appendix).

	Dependent variable: Total % Tree Loss			
	No outlier & No big three city	No outlier & No big three city	No outlier & No central district	No outlier & No central district
AKP	0.031**	0.025*	0.042***	0.036**
	(0.013)	(0.013)	(0.014)	(0.014)
Ave. Pop Growth	0.000	0.000	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Nightlight Diff.	0.487***	0.142	0.242**	0.108
	(0.157)	(0.167)	(0.102)	(0.111)
Mining Share	2.666*	2.732*	2.901*	2.962*
	(1.465)	(1.472)	(1.537)	(1.549)
No. of New Hydropower Plants (log)	0.056***	0.050***	0.054***	0.047**
	(0.018)	(0.019)	(0.020)	(0.021)
No. of Conflicts (log)	-0.008	-0.009	-0.023*	-0.024**
	(0.009)	(0.009)	(0.012)	(0.012)
Coastal District	0.090	0.084	0.029	0.020
	(0.069)	(0.070)	(0.064)	(0.065)
Total No. of Fires (log)	0.008	0.007	0.011**	0.012**
	(0.005)	(0.005)	(0.005)	(0.005)
Average Temp. Range	0.022**	0.014	0.038***	0.031***
	(0.011)	(0.011)	(0.010)	(0.011)
Average Precipitation	0.002**	0.001	0.002**	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Baseline Green (share)	0.568***	0.573***	0.784***	0.794***
	(0.084)	(0.084)	(0.095)	(0.097)
Num.Obs.	2357	2357	2356	2356
R2	0.530	0.538	0.535	0.542
R2 Adj.	0.511	0.519	0.517	0.524
Province FE	Yes	Yes	Yes	Yes
Period FE	No	Yes	No	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01
Standard errors are clustered at the district level

Table 3: The correlates of tree loss in Turkey (excluding major cities and central districts)

As a further robustness check, I created another variable to measure the intensity of the local AKP rule. Instead of weighting by the population under AKP municipalities, I created a dummy variable that takes the value one if AKP mayors govern all people in the district. The rest is coded as zero. Note that this is the most conservative measure for local AKP rule since many AKP-ruled municipalities are coded as 0 in this approach. Hence, this variable compares districts exclusively governed by AKP mayors with others. The results are presented in the Appendix section and repeated for all the analyses conducted above.[18]

5 Conclusion

This paper provided the first systemic empirical analysis on the correlates of deforestation in Turkey. The results show that deforestation in districts with AKP municipalities is higher than in non-AKP municipalities. Similarly,

[18]See Table A2, Table A3, and Table A4 in the Appendix.

new hydropower plants and increased mining activities are positively associated with deforestation. These results are robust to including a different set of controls and model specifications. By providing an empirical analysis, this paper aims to contribute to the debates on the drivers of deforestation in Turkey.

Although the results show that AKP municipalities are more likely to witness tree loss, they do not tell us *why* this is the case. One plausible mechanism is rent-seeking: AKP municipalities are more flexible in catering to private interests at the expense of the environment when judicial oversight does not work and the media is politically captured. It could also be that AKP municipalities might be more willing to sacrifice the environment in change for votes with various infrastructural, residential, and industrial projects. The empirical analysis presented in this paper cannot disentangle these different mechanisms, and future studies should focus more on identifying distinct mechanisms that affect tree loss.

The impact of other factors is easier to interpret and put into context. The results show that mining activities and new hydropower plants positively correlate with deforestation. Holding everything else constant, going from no mining activity to the maximum level of activity observed in the sample is correlated with higher deforestation by an area of around 253 football pitches in a given district. The adverse impact of the hydropower plants is around half of the mining impact since building six new power plants, the maximum observed in the sample, is positively correlated with deforestation by around 120 football pitches. It should be kept in mind that these results should not be interpreted as the "causal" effects since the research design does not allow us a clear causal identification strategy.

On the other hand, conflict does not seem to be correlated with deforestation, unlike the findings of the previous studies. Two reasons could drive this. First, these studies focus on the 1990s, during which the conflict between Kurdish insurgents and the state forces was the most intense (Gurses 2012; Van Etten et al. 2008). This paper, on the other hand, focuses on the post-2000s, in which the intensity of conflict was much lower. Second, both studies that found an impact focus only on one region, while this study conducts a systemic analysis of all districts for three different election periods (Gurses 2012; Van Etten et al. 2008).

Satellite data allows us to study the correlates of deforestation in Turkey while it is not feasible to conduct the same analysis with official data. In addition to studying deforestation, future studies can also leverage remote sensing to study other environmental problems such as air pollution (Gupta et al. 2006) and water quality (Ritchie et al. 2003), and analyze how politics, both at the national and local level, impacts these environmental issues. Using such data alleviates the need for official data, which might be distorted, low quality, aggregated at levels that mask the variation, or nonexistent at all. Future studies should look more for such data sources, especially in authoritarian settings where governments manipulate information (Adiguzel et al. 2020).

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6 Appendix

	Dependent variable: Total % Tree Loss					
	1	2	3	4	5	6
AKP	0.045**	0.048**	0.048**	0.057***	0.054***	0.048**
	(0.022)	(0.022)	(0.022)	(0.022)	(0.019)	(0.019)
Ave. Pop Growth	0.003*	0.003*	0.003*	0.002	0.002	0.001
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Nightlight Diff.	0.410***	0.412***	0.418***	0.508***	0.367***	0.191
	(0.136)	(0.138)	(0.138)	(0.135)	(0.124)	(0.137)
Mining Share	5.569***	5.731***	5.809***	5.438***	4.621**	4.556**
	(1.975)	(1.987)	(1.999)	(1.949)	(2.281)	(2.248)
No. of New Hydropower Plants (log)	0.054**	0.055***	0.052**	0.037*	0.031	0.024
	(0.021)	(0.021)	(0.021)	(0.021)	(0.022)	(0.023)
No. of Conflicts (log)	-0.004	-0.004	-0.007	-0.006	-0.008	-0.009
	(0.029)	(0.029)	(0.029)	(0.030)	(0.026)	(0.026)
Coastal District		0.081	0.078	0.046	0.117	0.107
		(0.115)	(0.116)	(0.117)	(0.109)	(0.110)
Total No. of Fires (log)			0.010	0.013*	0.020***	0.020***
			(0.008)	(0.008)	(0.007)	(0.007)
Average Temp. Range				-0.023	0.046***	0.037**
				(0.018)	(0.017)	(0.018)
Average Precipitation				0.005***	0.002	0.001
				(0.002)	(0.002)	(0.002)
Baseline Green (share)					1.289***	1.299***
					(0.154)	(0.156)
Num.Obs.	2754	2754	2754	2742	2742	2742
R2	0.365	0.365	0.366	0.380	0.442	0.447
R2 Adj.	0.344	0.345	0.345	0.359	0.423	0.428
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Period FE	No	No	No	No	No	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01
Standard errors are clustered at the district level

Table 4: The correlates of tree loss in Turkey (including outliers)

6.1 Alternative measure for the local AKP rule

	Dependent variable: Total % Tree Loss					
	1	2	3	4	5	6
AKP (binary)	0.032***	0.032**	0.034***	0.034***	0.042***	0.026**
	(0.012)	(0.013)	(0.013)	(0.013)	(0.012)	(0.012)
Ave. Pop Growth	0.001	0.001	0.001	0.001	0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Nightlight Diff.	0.229**	0.229**	0.234**	0.318***	0.225**	0.092
	(0.101)	(0.101)	(0.102)	(0.107)	(0.099)	(0.109)
Mining Share	3.611***	3.609***	3.640***	3.466**	2.856*	2.904*
	(1.381)	(1.380)	(1.388)	(1.384)	(1.542)	(1.558)
No. of New Hydropower Plants (log)	0.067***	0.067***	0.065***	0.055***	0.051***	0.046**
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.019)
No. of Conflicts (log)	-0.013	-0.013	-0.015	-0.015	-0.016	-0.019*
	(0.013)	(0.013)	(0.013)	(0.013)	(0.011)	(0.011)
Coastal District		-0.001	-0.002	-0.021	0.022	0.013
		(0.069)	(0.069)	(0.069)	(0.064)	(0.064)
Total No. of Fires (log)			0.007	0.009*	0.013***	0.013***
			(0.005)	(0.005)	(0.005)	(0.005)
Average Temp. Range				-0.009	0.033***	0.027**
				(0.010)	(0.011)	(0.011)
Average Precipitation				0.004***	0.002**	0.001
				(0.001)	(0.001)	(0.001)
Baseline Green (share)					0.777***	0.782***
					(0.095)	(0.096)
Num.Obs.	2572	2572	2572	2563	2563	2563
R2	0.479	0.479	0.480	0.492	0.540	0.546
R2 Adj.	0.461	0.461	0.462	0.474	0.524	0.529
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Period FE	No	No	No	No	No	Yes

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

Standard errors are clustered at the district level

Table 5: The correlates of tree loss in Turkey (alternative AKP measure)

	Dependent variable: Total % Tree Loss			
	No outlier & No big three city	No outlier & No big three city	No outlier & No central district	No outlier & No central district
AKP (binary)	0.038***	0.022*	0.044***	0.028**
	(0.012)	(0.012)	(0.012)	(0.013)
Ave. Pop Growth	0.000	0.000	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Nightlight Diff.	0.467***	0.147	0.242**	0.117
	(0.157)	(0.167)	(0.103)	(0.111)
Mining Share	2.632*	2.693*	2.849*	2.901*
	(1.467)	(1.479)	(1.544)	(1.562)
No. of New Hydropower Plants (log)	0.057***	0.051***	0.054***	0.048**
	(0.018)	(0.019)	(0.020)	(0.020)
No. of Conflicts (log)	-0.007	-0.009	-0.023*	-0.025**
	(0.009)	(0.009)	(0.012)	(0.012)
Coastal District	0.088	0.081	0.025	0.016
	(0.069)	(0.070)	(0.064)	(0.064)
Total No. of Fires (log)	0.009*	0.008*	0.013**	0.012**
	(0.005)	(0.005)	(0.005)	(0.005)
Average Temp. Range	0.021**	0.014	0.038***	0.032***
	(0.011)	(0.011)	(0.010)	(0.011)
Average Precipitation	0.002**	0.001	0.002**	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Baseline Green (share)	0.575***	0.576***	0.791***	0.798***
	(0.084)	(0.085)	(0.095)	(0.097)
Num.Obs.	2357	2357	2356	2356
R2	0.531	0.537	0.536	0.542
R2 Adj.	0.513	0.519	0.518	0.523
Province FE	Yes	Yes	Yes	Yes
Period FE	No	Yes	No	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01
Standard errors are clustered at the district level

Table 6: The correlates of tree loss in Turkey (excluding major cities and central districts) (alternative AKP measure)

	Dependent variable: Total % Tree Loss					
	1	2	3	4	5	6
AKP (binary)	0.039**	0.041**	0.044**	0.049***	0.060***	0.041**
	(0.019)	(0.019)	(0.019)	(0.019)	(0.017)	(0.018)
Ave. Pop Growth	0.003*	0.003*	0.003*	0.002	0.002	0.001
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Nightlight Diff.	0.414***	0.417***	0.422***	0.511***	0.362***	0.203
	(0.138)	(0.139)	(0.140)	(0.137)	(0.126)	(0.139)
Mining Share	5.518***	5.664***	5.756***	5.365***	4.551**	4.495**
	(1.987)	(1.999)	(2.012)	(1.960)	(2.281)	(2.264)
No. of New Hydropower Plants (log)	0.055***	0.055***	0.052**	0.038*	0.031	0.025
	(0.021)	(0.021)	(0.021)	(0.021)	(0.022)	(0.023)
No. of Conflicts (log)	-0.003	-0.003	-0.007	-0.006	-0.007	-0.008
	(0.029)	(0.029)	(0.030)	(0.030)	(0.026)	(0.026)
Coastal District		0.075	0.073	0.038	0.111	0.101
		(0.115)	(0.116)	(0.117)	(0.109)	(0.110)
Total No. of Fires (log)			0.011	0.015*	0.022***	0.022***
			(0.008)	(0.008)	(0.007)	(0.007)
Average Temp. Range				-0.024	0.045***	0.037**
				(0.018)	(0.017)	(0.018)
Average Precipitation				0.005***	0.002	0.001
				(0.002)	(0.002)	(0.002)
Baseline Green (share)					1.300***	1.305***
					(0.155)	(0.157)
Num.Obs.	2754	2754	2754	2742	2742	2742
R2	0.364	0.365	0.366	0.380	0.443	0.447
R2 Adj.	0.344	0.344	0.345	0.359	0.424	0.427
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Period FE	No	No	No	No	No	Yes

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Standard errors are clustered at the district level

Table 7: The correlates of tree loss in Turkey (including outliers) (alternative AKP measure)

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