Assessing the Impact of Irrigation on Conflict in Southeastern Turkey

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Kurdish Insurgency

- 44% of the population in Southeast living on less than US$1.1/day (Saatci and Akpinar, 2007)
- "The Kurdish identity question was expressed in terms of regional economic inequalities and suggested a socialist solution" (Yavuz, 2001: 10)
- Originally a "peasant movement", recruiting largely from farming communities (Yavuz, 2001: 10)

Southeastern Anatolia Project (GAP)

- Infrastructural development project started in 1985
- Goals:
  - 19 dams
  - 22 hydropower plants
  - 1.8 million hectares of irrigation
- Income gains associated with switch to irrigated farming: 3-7x (Tokdemir et. al., 2016)
- Government hoped it would reduce appeal of PKK

TURKEY'S OUTREACH TO THE KURDS OF THE SOUTHEAST: GRAPPLING WITH THE ROOT CAUSES OF THE PKK PROBLEM

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Original Classification: SECRET Current Classification: SECRET

WikiLeaks

is in general agreement with the government on the need for a broad approach, although with significant redlines. Most GOT officials believe greater focus on economic and social development in Turkey's southeast will have the greatest positive impact on ethnic Kurds' views towards the Turkish state. If Kurds are gainfully employed, have better educational opportunities, and see increased levels of infrastructure development throughout their region, their affinity for the terrorist PKK will wane further.

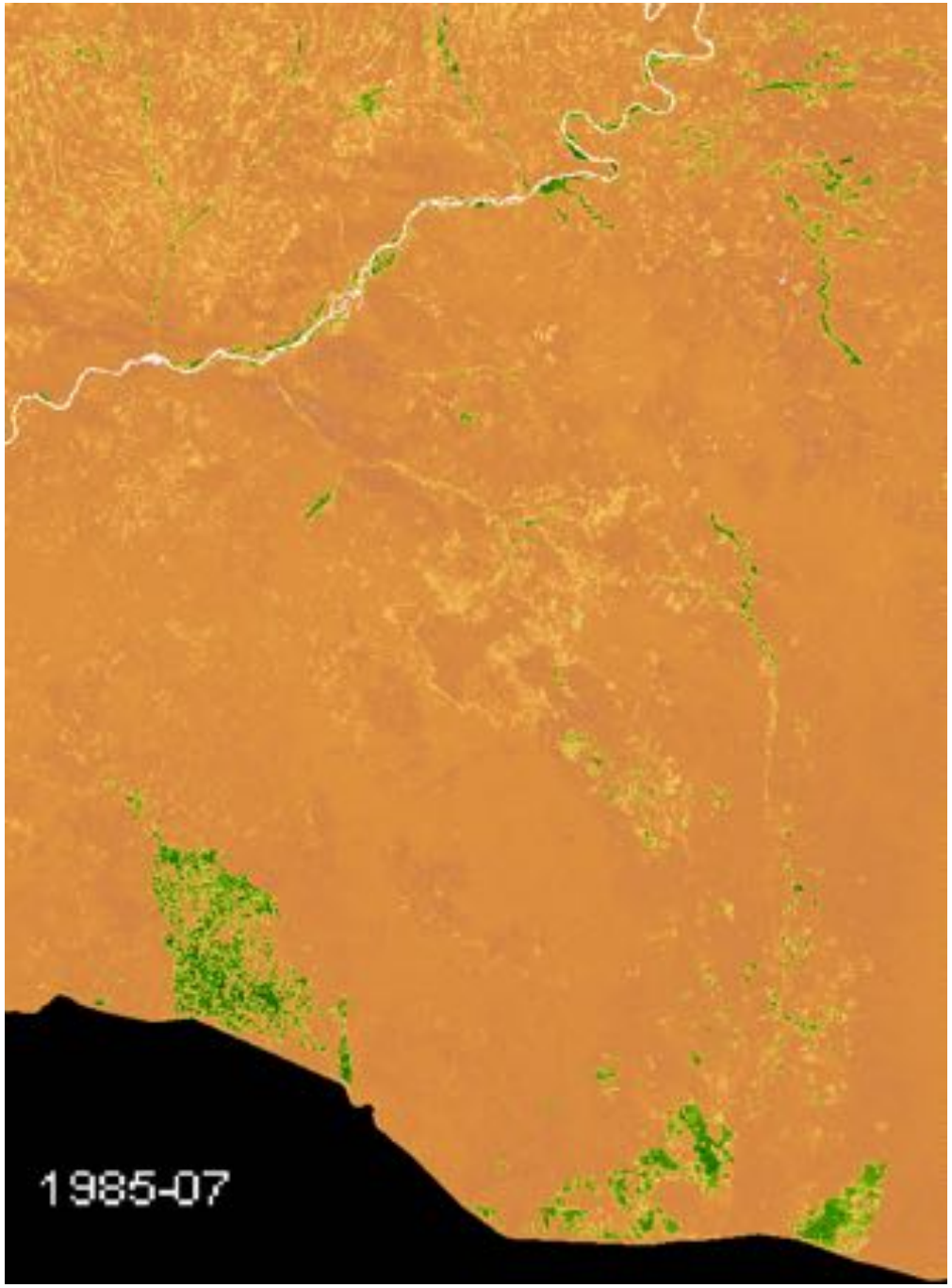
4. (C) The GOT has ambitious plans, many of them laid out in the GOT's Action Plan. A top priority is ensuring completion of the massive Southeast Anatolia Project (GAP) within five years. Ekren told us he is also looking at creating a

(Government Of Turkey)

Interviews with Farmers

- Farmers who received GAP irrigation:
  - "**Our view of the state changed positively... we had hatred before, but now they started investing in the Southeast**"
  - "We did not trust the state before, but it brought electricity, water, phone, etc. to us and now we trust the state a lot"
  - "At last the state turned its face towards us"
  - "We did not see any accomplishments of governments in the past—we are a little bit happy to see some now." (Harris, 2016)

- Farmer who did not receive irrigation:
  - "Why should I not support Öcalan?"



A GAP in the literature

- Lots of work assessing the impact of infrastructure projects on development
  - Duflo and Pande (2008): Dams decrease poverty by tempering rainfall shocks
- Lots of work on the relationship between development and civil conflict
  - Harrari and LaFerrara (2017): Rainfall shocks increase conflict likelihood in Africa
  - Blattman and Miguel (2010): **"The most promising avenue for new empirical research is on the subnational scale, analyzing conflict causes, conduct, and consequences at the level of armed groups, communities, and individuals."**
- Very little work on how infrastructure projects affect conflict.
  - Yet many governments spend billions targeting infrastructural investments in the hopes that they might alleviate conflict

This Paper

- Assesses the impact of state-provided irrigation on conflict incidence and insurgent recruitment in Southeastern Turkey
  - using a wide array of original social, political, and economic covariates
  - at a very high spatial resolution
    - 10km and 5km grid-cells
- Model design is informed by a wide array of sources including ethnographies, Wikileaks, and fieldwork interviews.

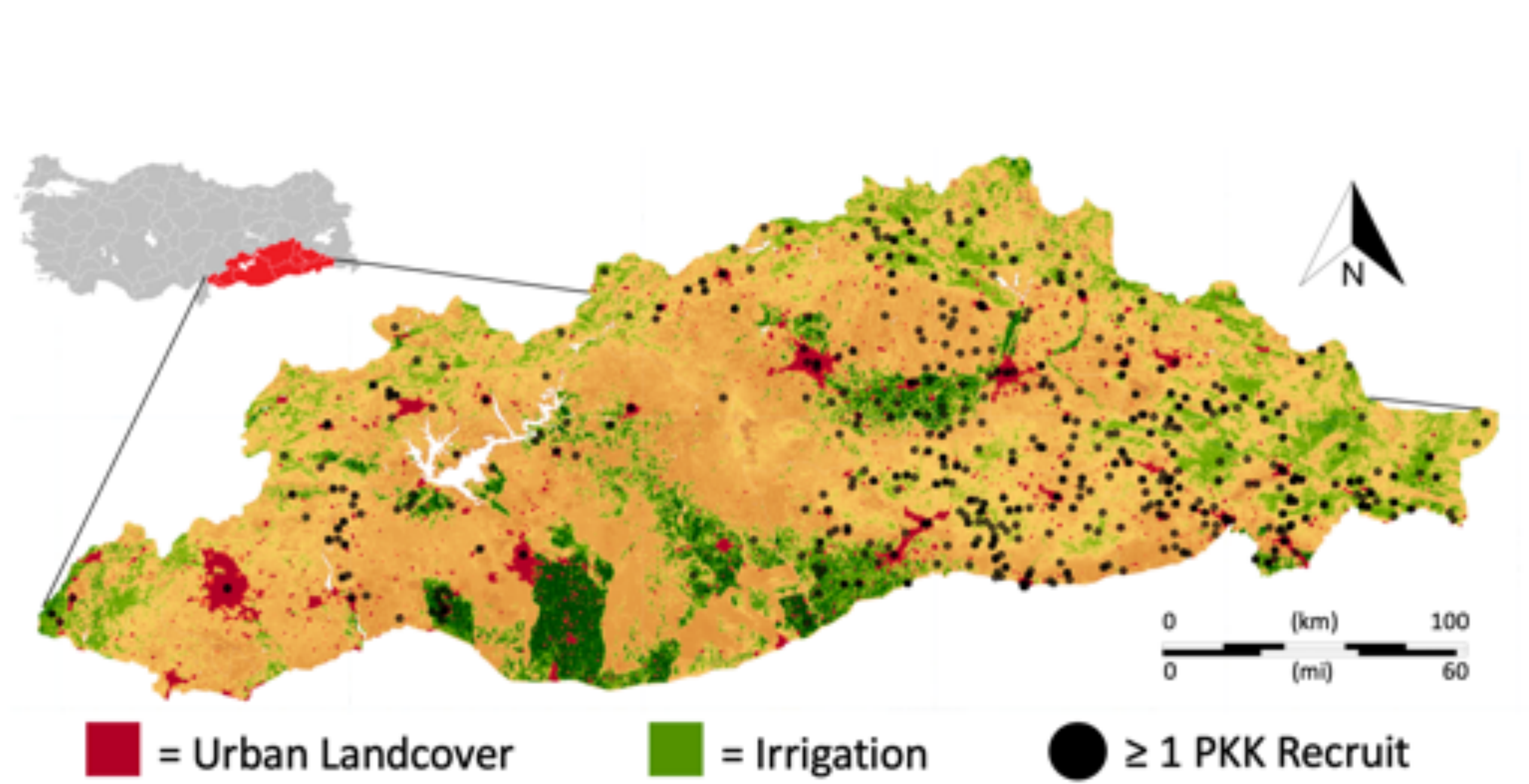
Main Findings

- Irrigation is negatively related to conflict incidence and recruitment.
  - Robust to alternative specifications: 4 different measures of irrigation, two different conflict datasets, and a highly detailed PKK recruitment dataset
- Panel models indicate that the **effect of irrigation is nearly 50% as strong as the effect of a ceasefire** between the PKK and Turkish Armed Forces.
  - This drops to around 20% if we exclude areas that never get irrigated
- Cross-sectional IV models suggest that **a fully irrigated area is nearly 8 times less likely to experience a conflict event than completely un-irrigated area.**
  - Effect strengthened when "conflict" is filtered to PKK-initiated attacks

Outline

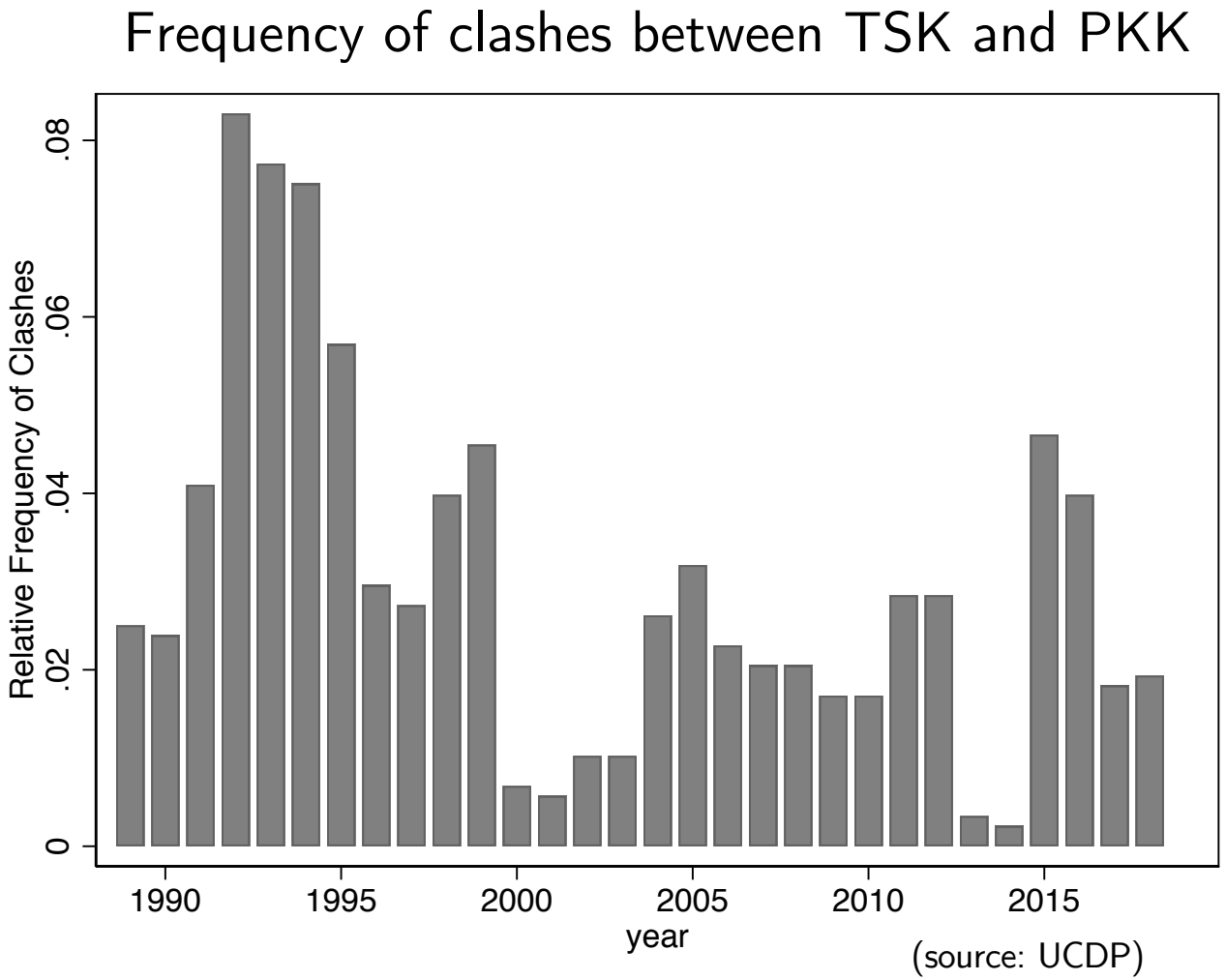
1. ~~Introduction~~
2. Data Collection
3. Empirical Strategy
4. Results
5. Conclusion

2. Data Collection

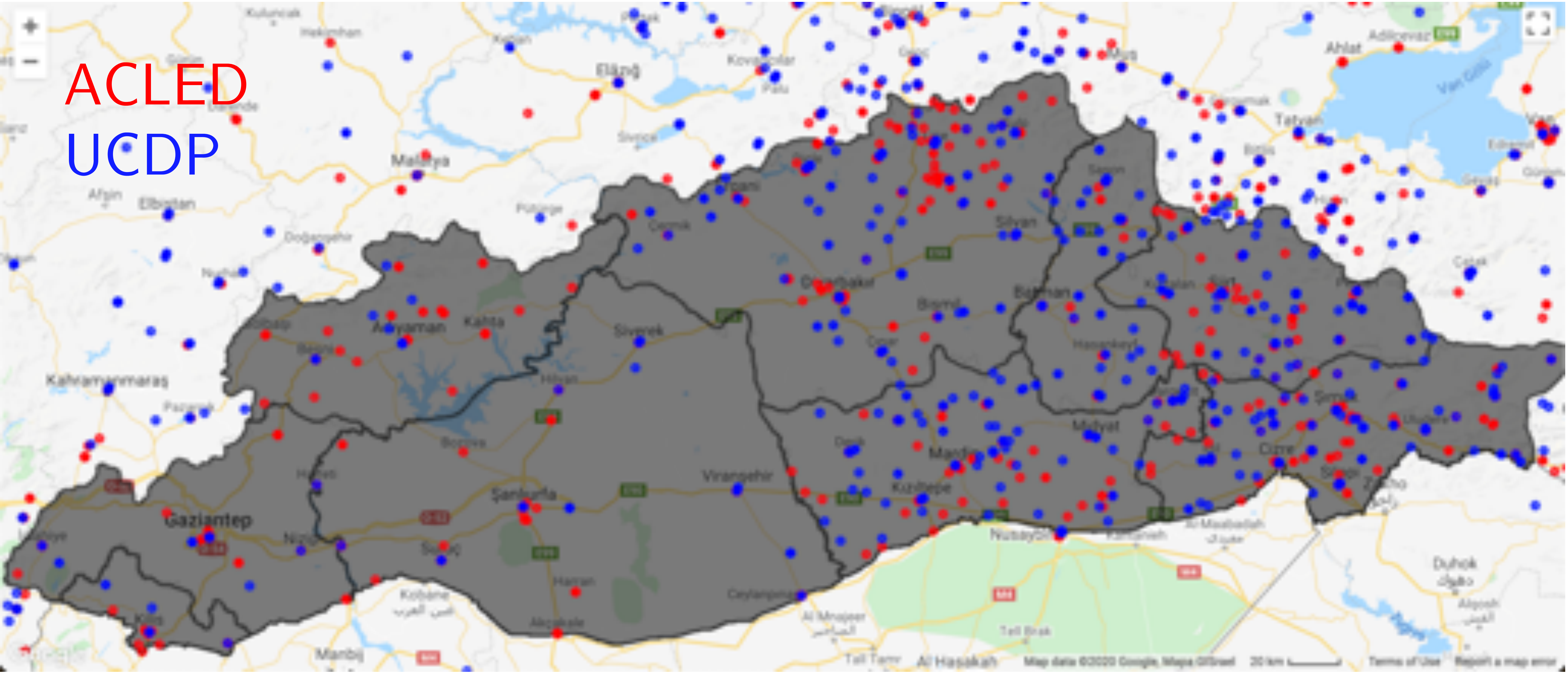

N
0
(km)
100
0
(mi)
60
= Urban Landcover
= Irrigation
≥ 1 PKK Recruit

Conflict

- Two main sources:
  - Uppsala Conflict Data Program (UCDP)
    - Time span: 1989-2019
    - For use in longitudinal analysis
  - Armed Conflict Location Event Dataset (ACLED)
    - 2016-2019
    - More detailed than UCDP, but only available for three years
    - Used in cross-sectional analysis
- Clashes between Turkish Armed Forces and PKK
- Binary measure
  - 0: no conflict event
  - 1: conflict event

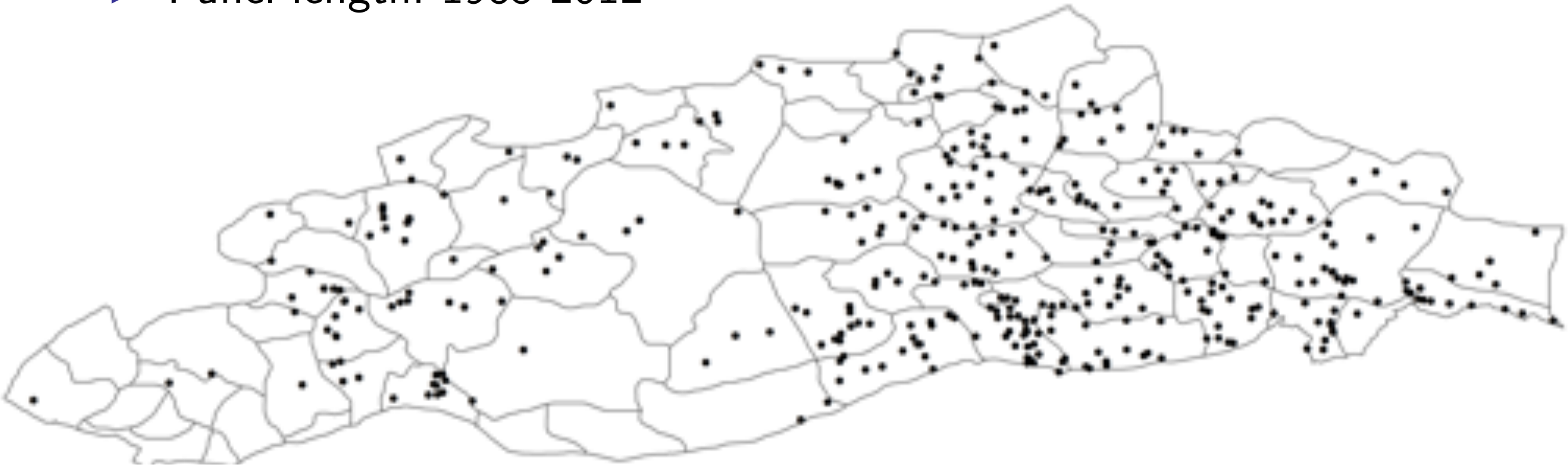


Conflict


ACLED
UCDP
Malatya
Elbistan
Kahramanmaraş
Gaziantep
Adıyaman
Kahta
Siverek
Şanlıurfa
Viranşehir
Diyarbakır
Silvan
Batman
Bismil
Midyat
Mardin
Kızıltepe
Cizre
Ahlat
Tatvan
Elazığ

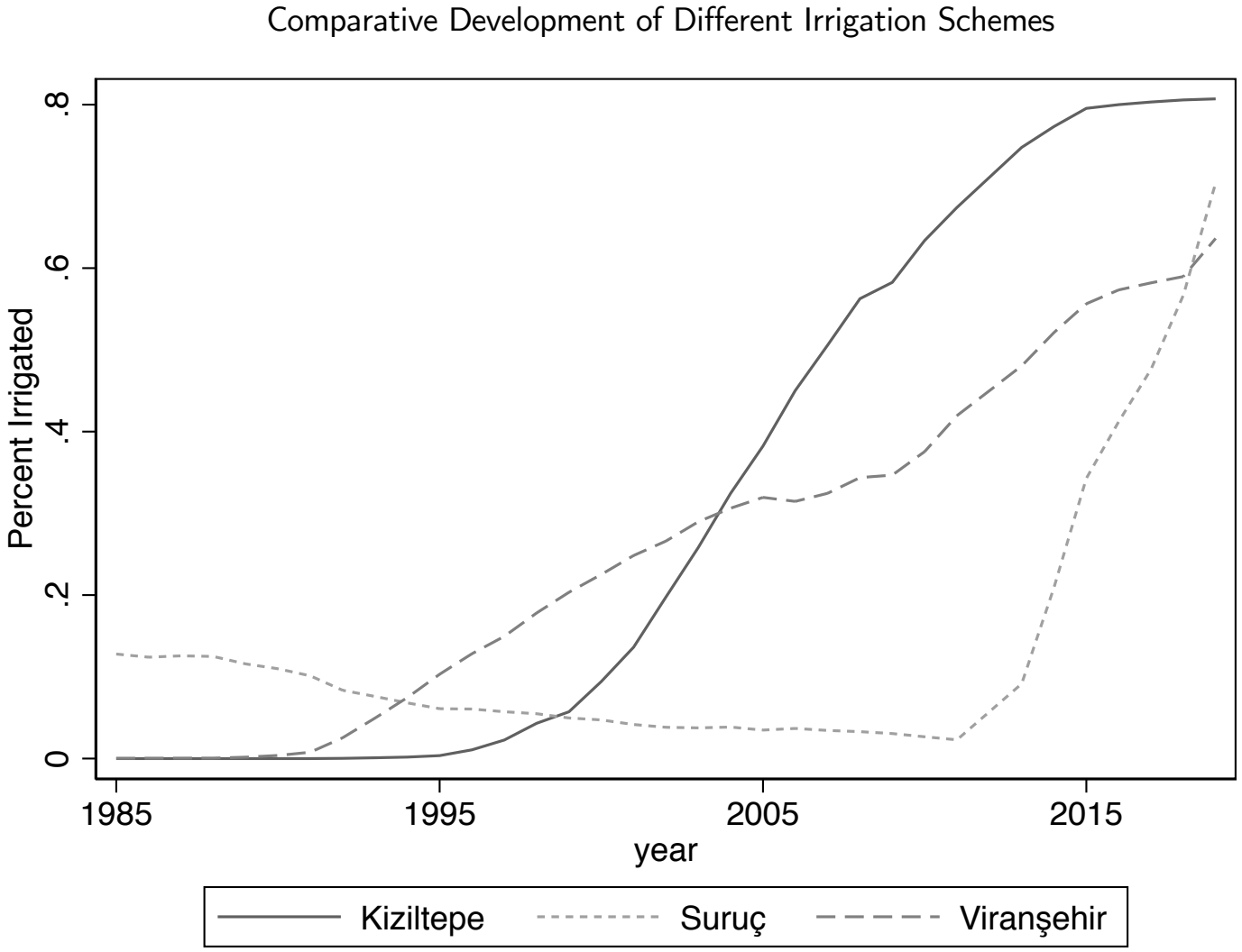
PKK Recruitment

- Data from Tezcür (2016), derived from PKK obituaries
- Each dot represents birthplace of ≥ 1 recruit
- Panel length: 1985-2012



Irrigation

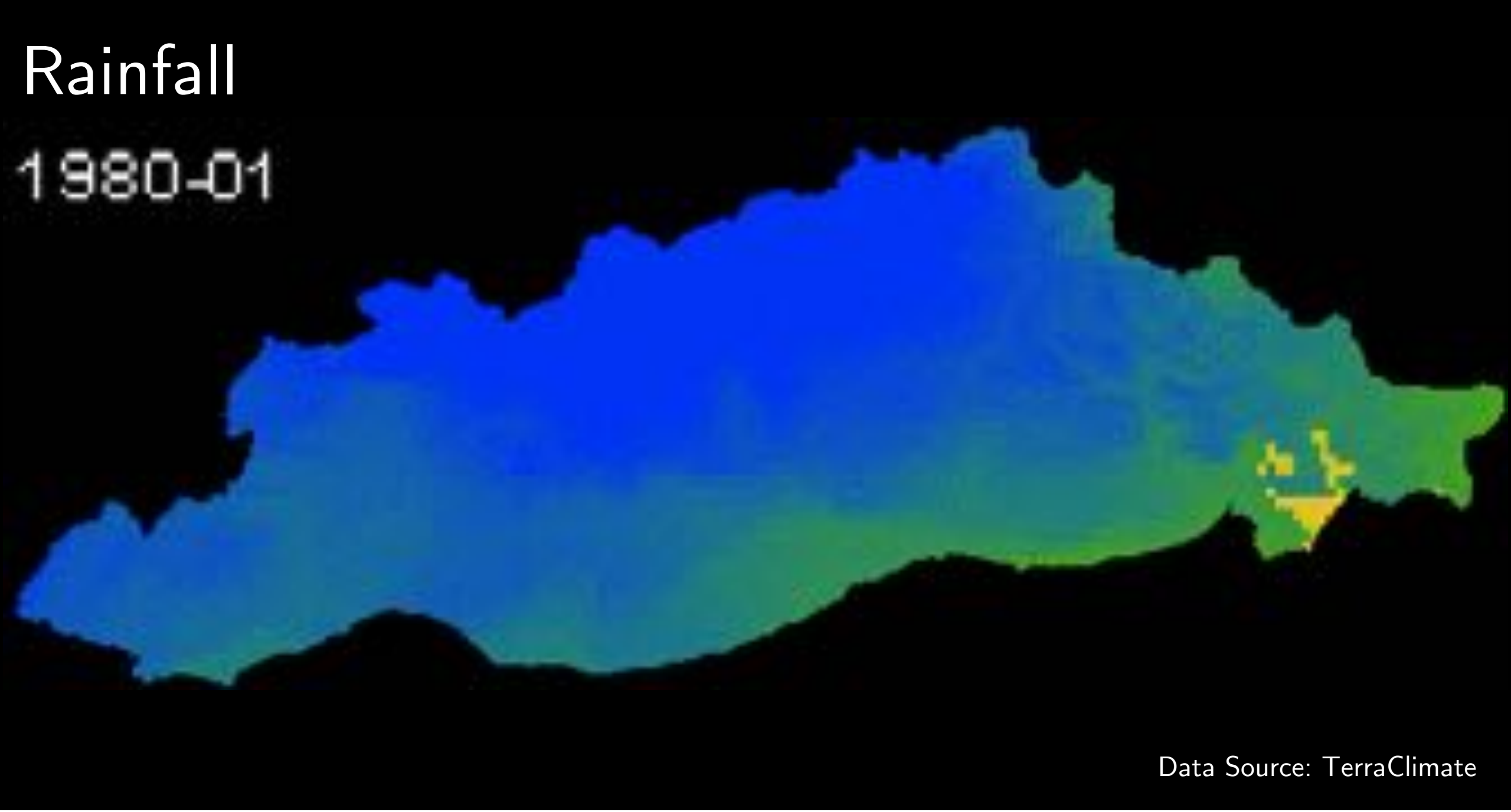
- Derived from satellite imagery analysis (NASA Landsat 5-8)
- Several different measures:
  - Percent of grid-cell under irrigation
  - Binary pre/post irrigation
  - Years since irrigation was introduced



Irrigation

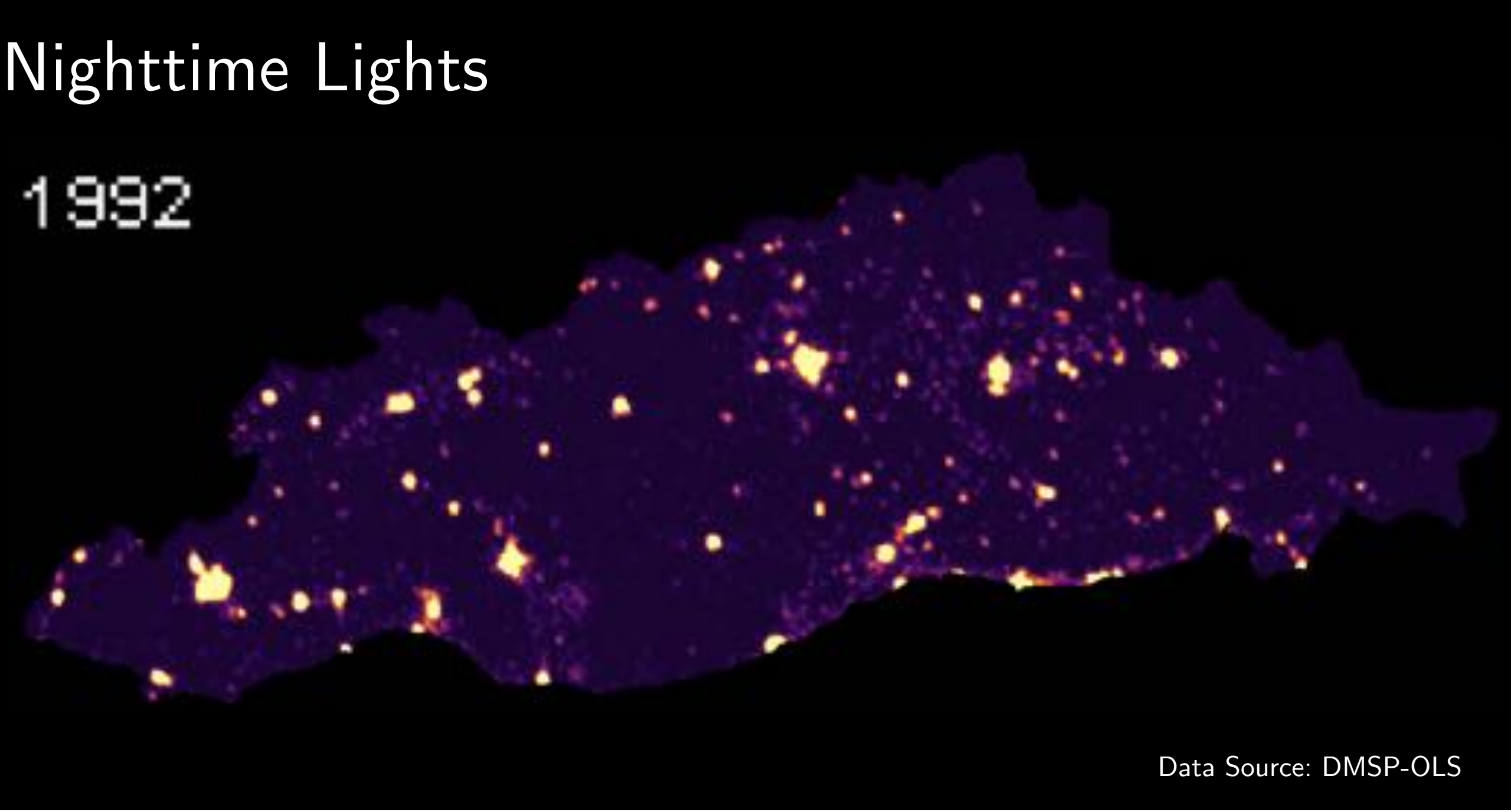
Data Source: LANDSAT 8

Rainfall



Data Source: TerraClimate

Nighttime Lights



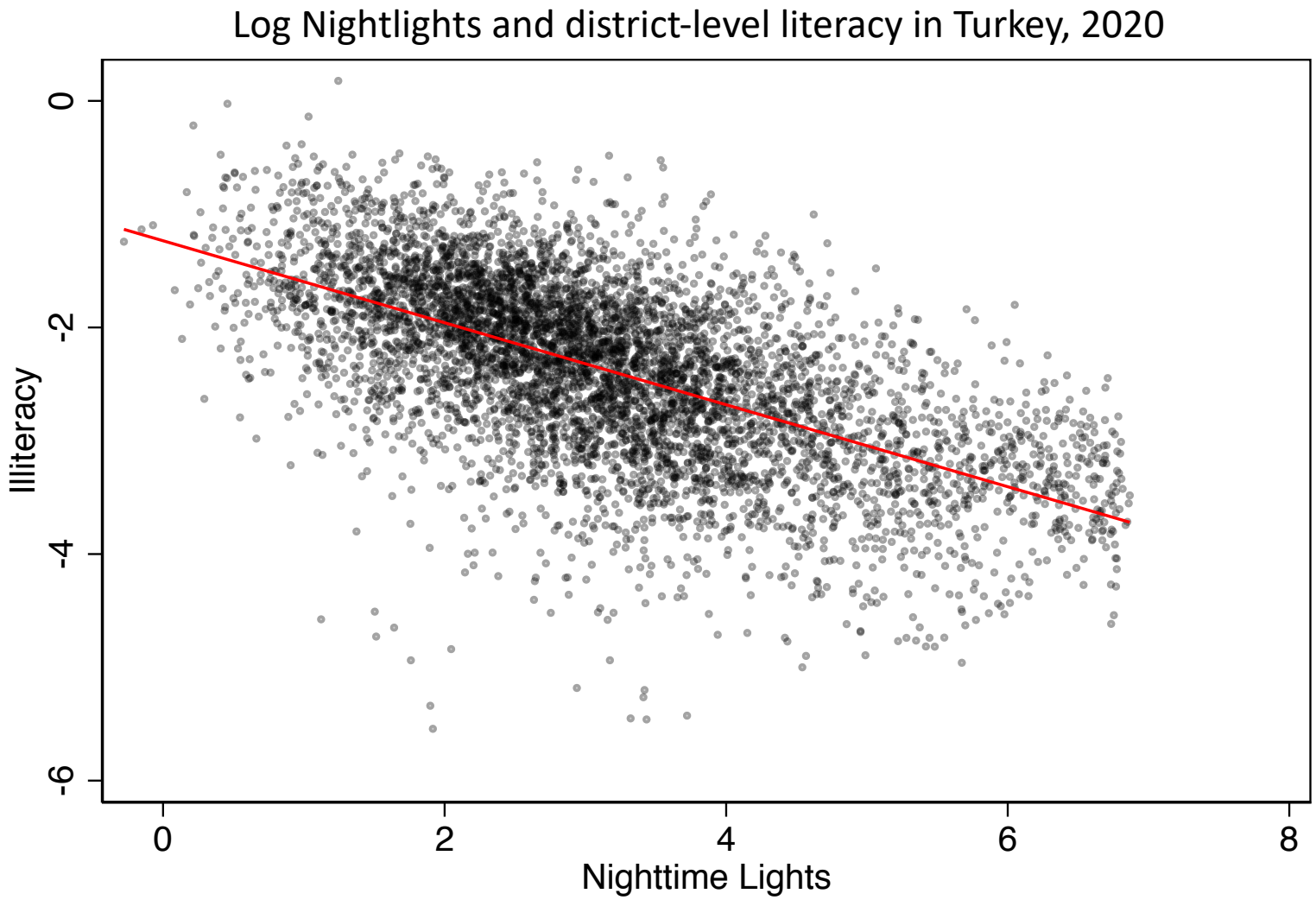
Data Source: DMSP-OLS

Nighttime Lights

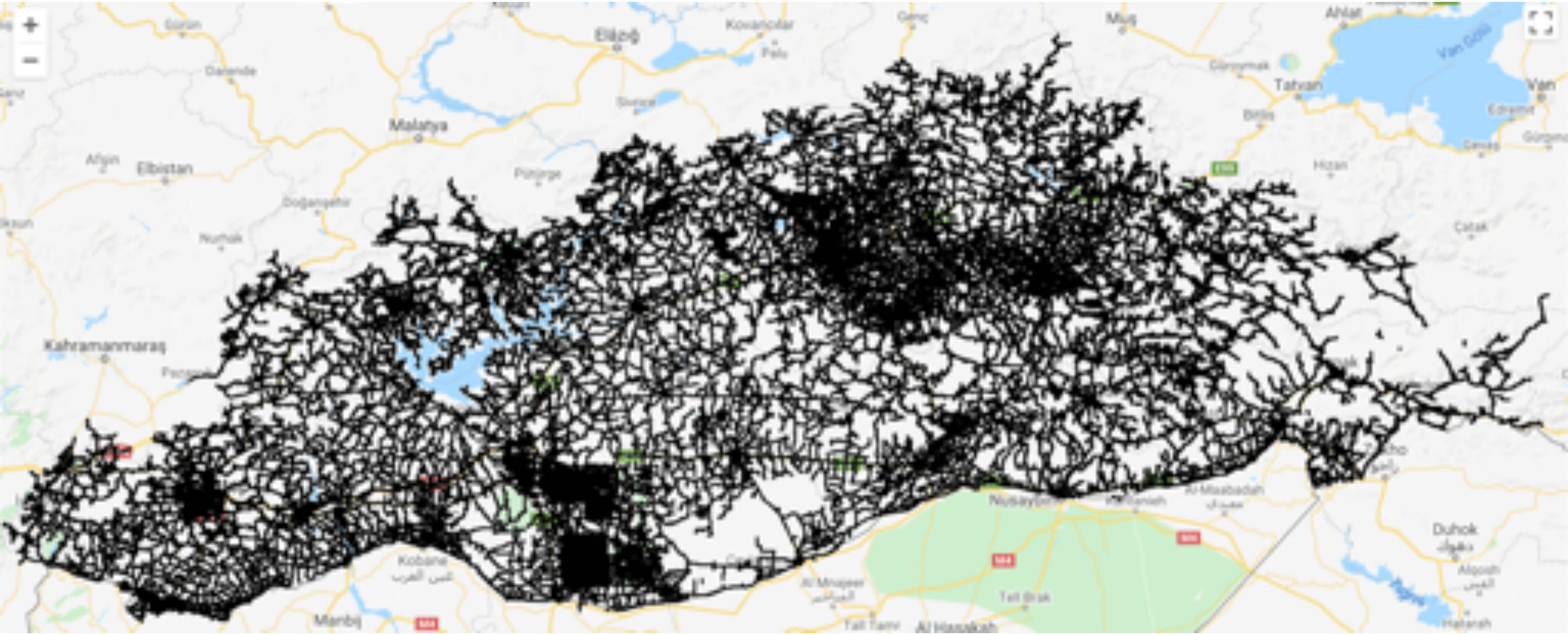
Data Source: VIIRS

Nighttime Lights

- Change in nightlights over time is typically correlated with development indicators
- Absolute level is a good indicator of urban landcover



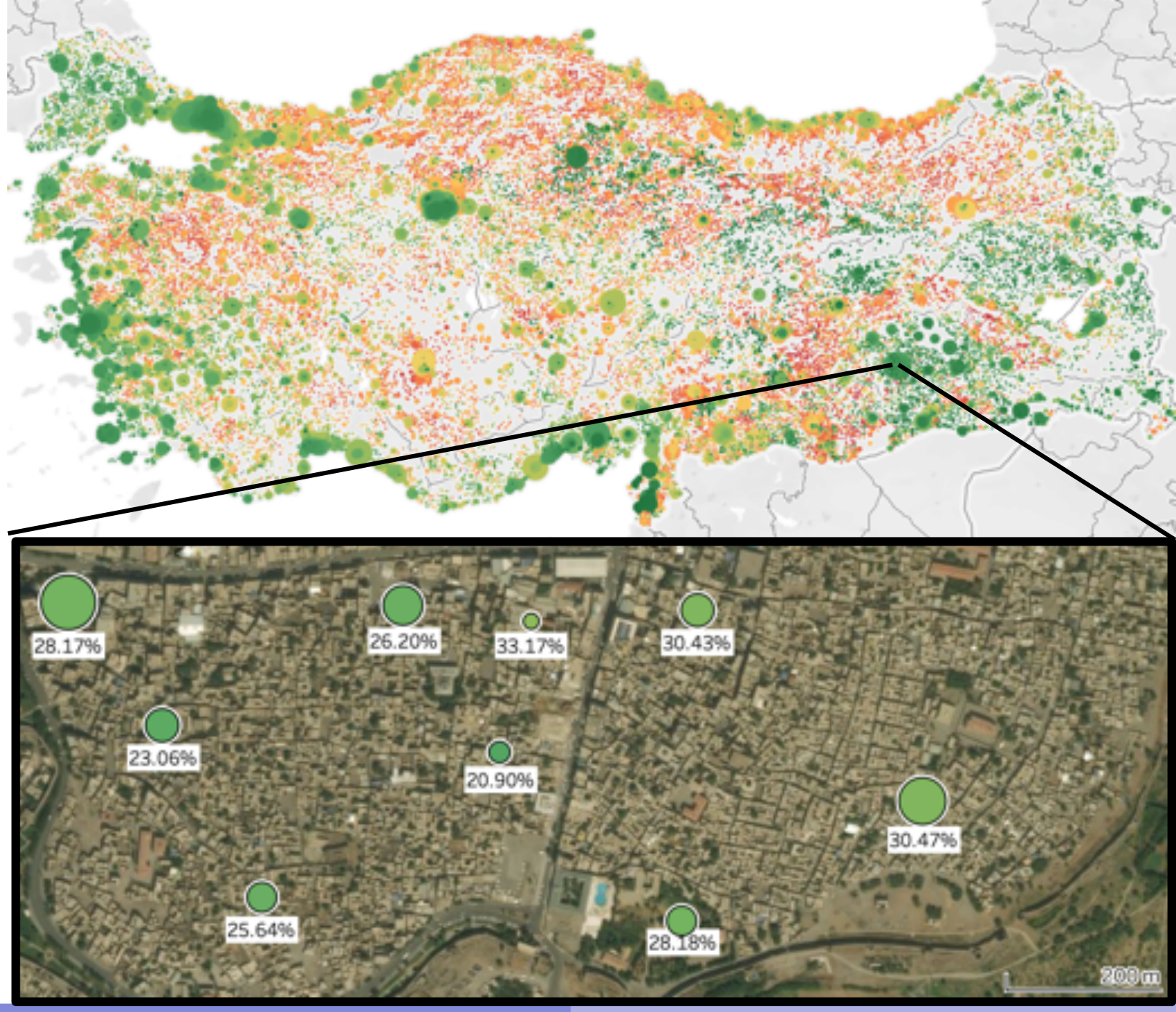
Roads



Data Source: UN HumData

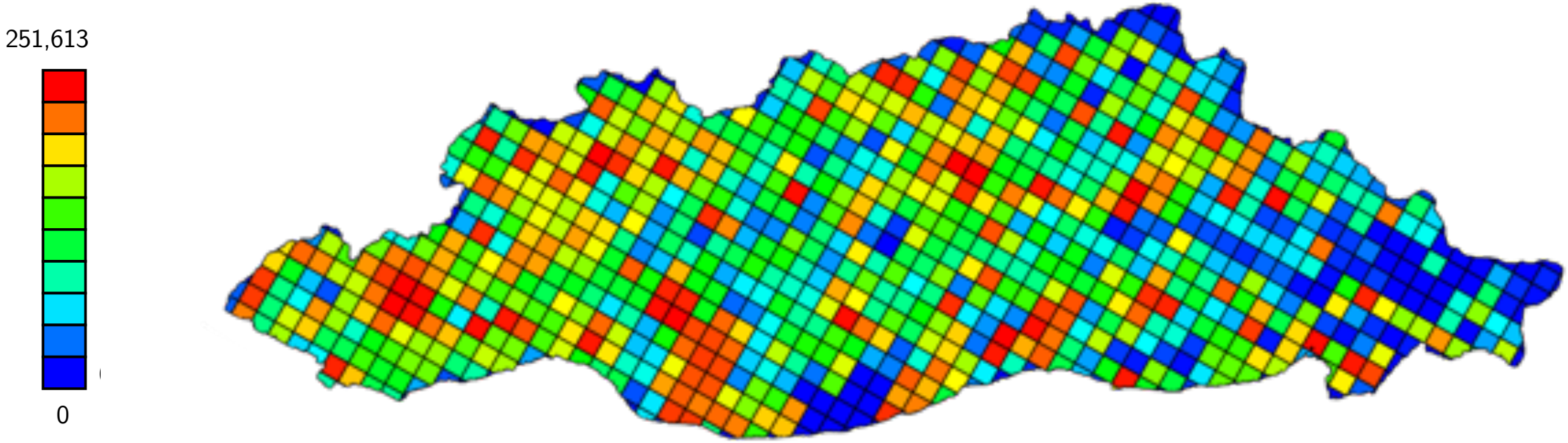
Political Outcomes

- 2.9 million ballot-box level election results
- 20 elections over 10 years (2009-2019)
- All levels (municipal, provincial, national)
- Source: T.C. Yüksek Seçim Kurulu



Population

- Derived from ballot-box data
  - Total number of voters registered at each polling station



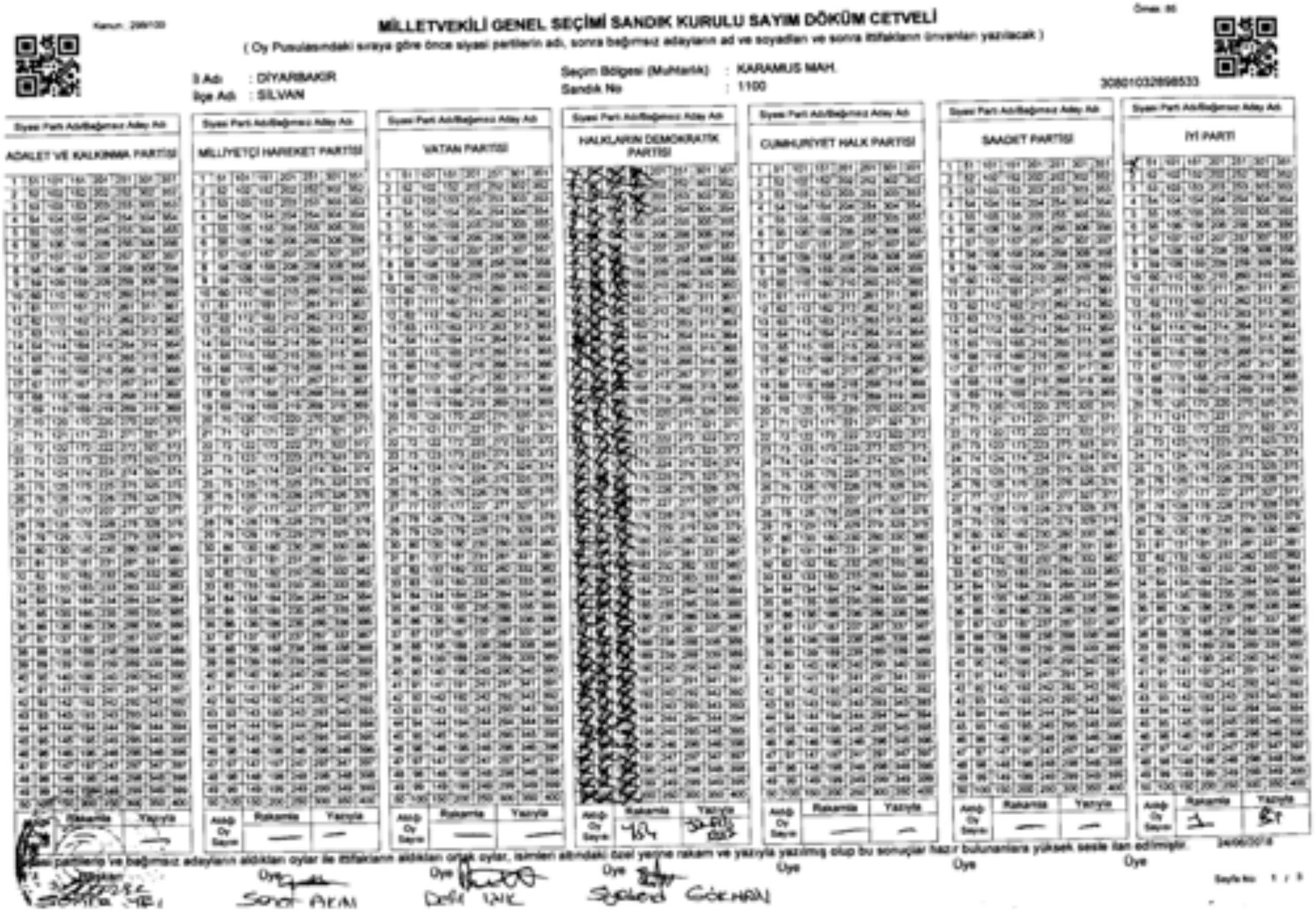
Aşiret Presence

- Tribal social structures are closely connected to both conflict and irrigation
  - Some tribes have allied with the PKK, others with the government (Köy Koruculari)
  - The distribution of land in tribal areas is effectively feudal– farmers don't benefit much from irrigation because they don't own the land.

- Tribes can be identified through their practice of "Birleşik Oy" ("Combined Voting")
  - Ethnographic accounts:
  - "many villages vote en masse—usually without making a single deviance—for the party chosen by the chieftain" (Guida, 2014: 176).
  - "it is widely known that members of Kurdish tribes do not vote for political parties but for what the chieftain imposes" Özcan (2006: 127)

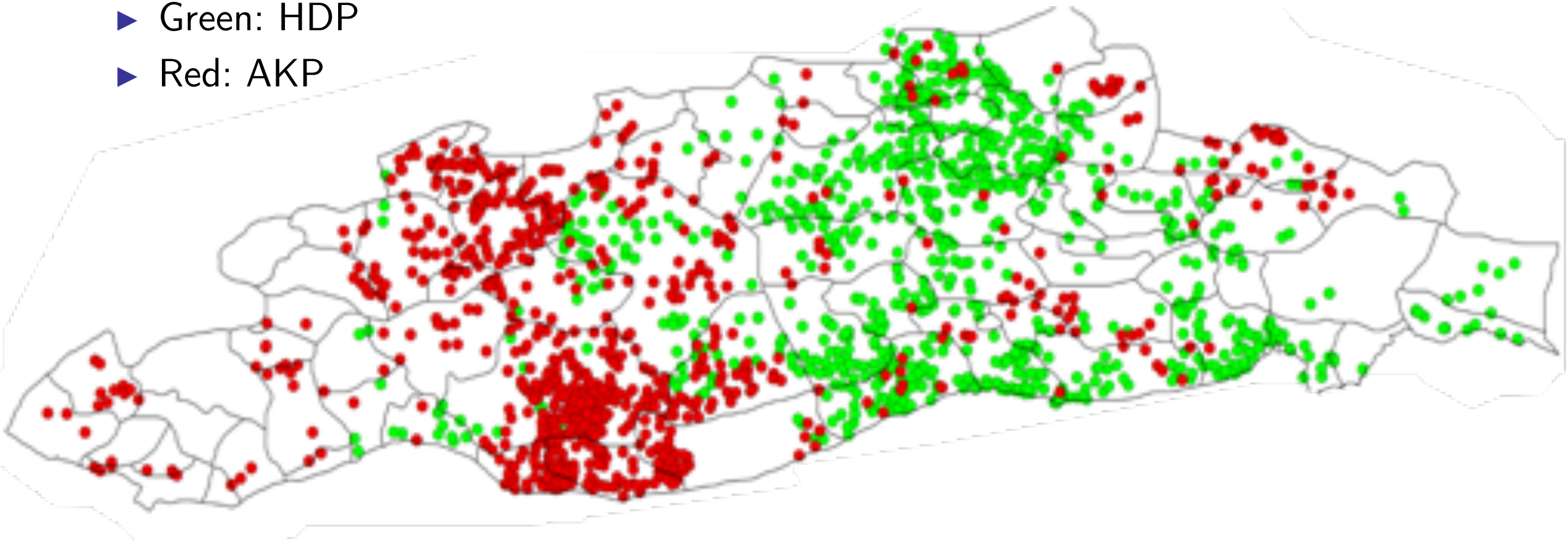
Aşiret Presence

- Birleşik Oy:
  - 0 AKP
  - 0 MHP
  - 0 CHP
  - 0 Saadet
  - 0 Vatan
  - 1 IYI
  - **154 HDP**



Aşiret Presence

- Instances of Birleşik Oy
  - Green: HDP
  - Red: AKP



Additional controls

- Cell area
- PKK-TSK ceasefire periods
- Syrian civil war onset
- Slope
- Elevation

3. Empirical Strategy

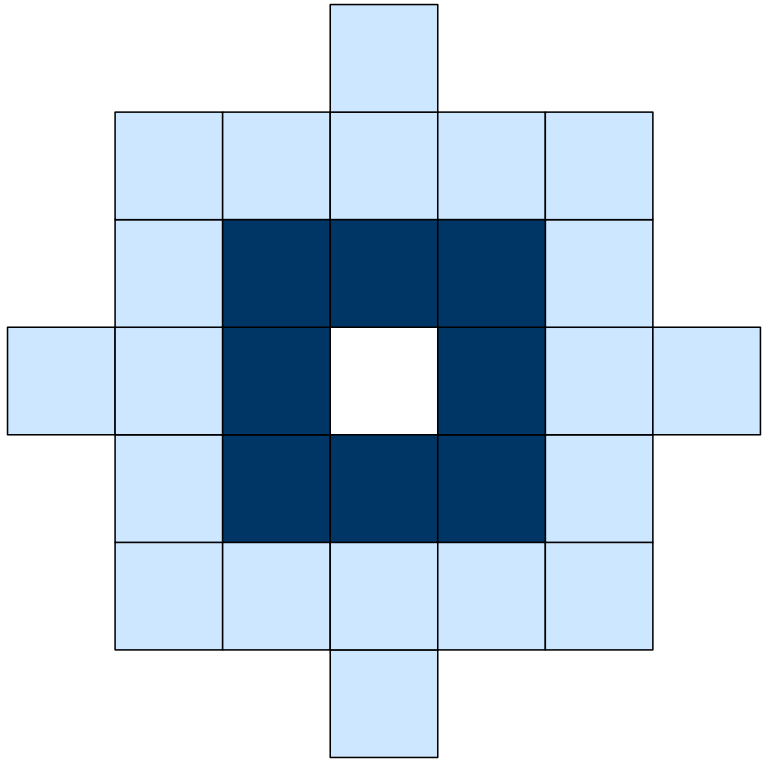
Research questions and models

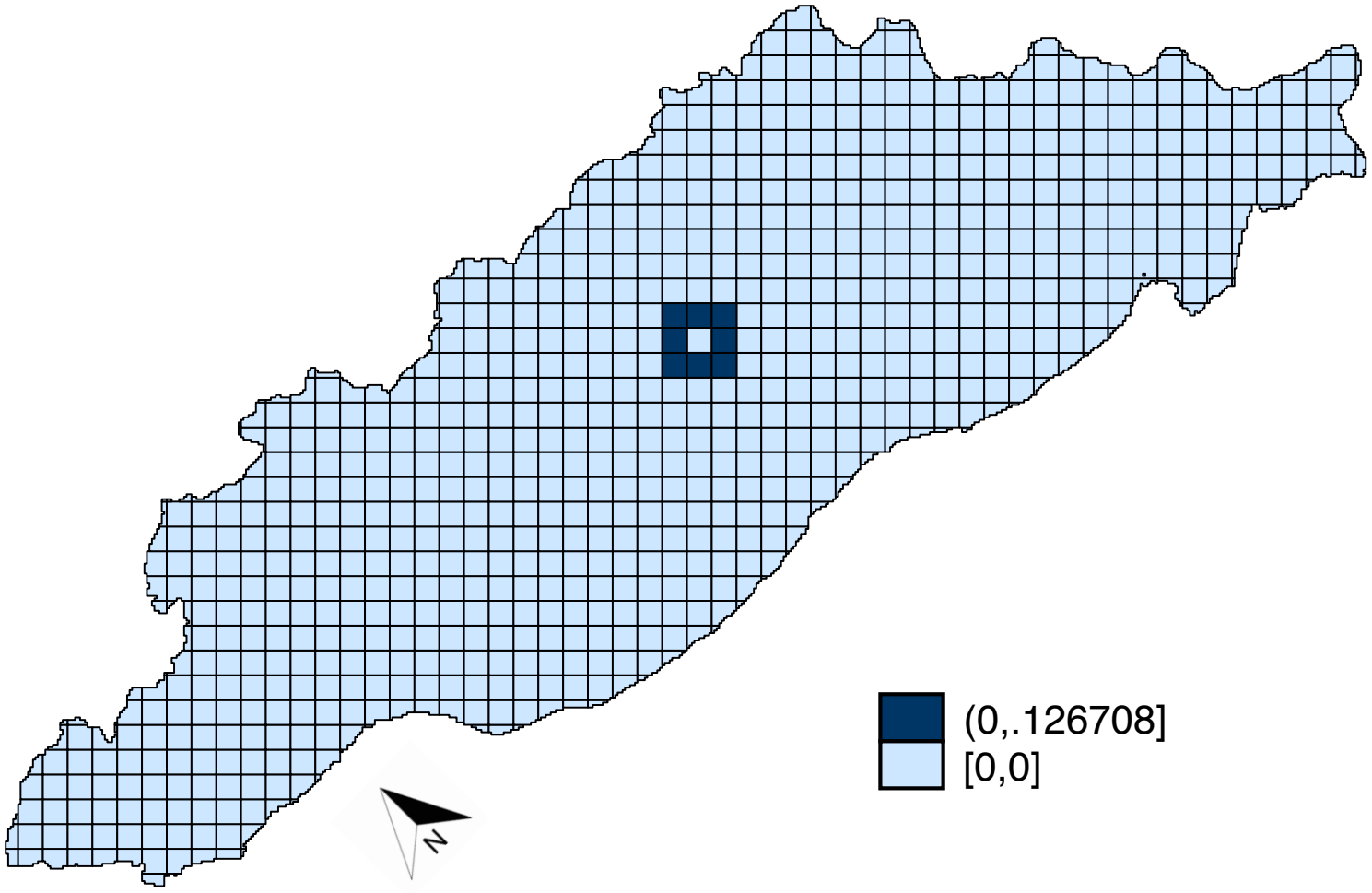
- Did conflict decrease following the introduction of irrigation?
  - Models:
    1. Panel OLS with spatial and serial correction (Conley, 1999; Hsiang 2010)
    2. Spatial Durbin Model estimated via ML (Harrari and LaFerrara, 2019)
  - 10km by 10km cells
  - Panel from 1985 to 2019

- Is conflict currently lower in irrigated areas?
  - Models:
    3. Spatially Autoregressive Instrumental Variables
  - 5km by 5km cells
  - Pooled cross-section (2016-2019)

Spatial Weighting Matrices

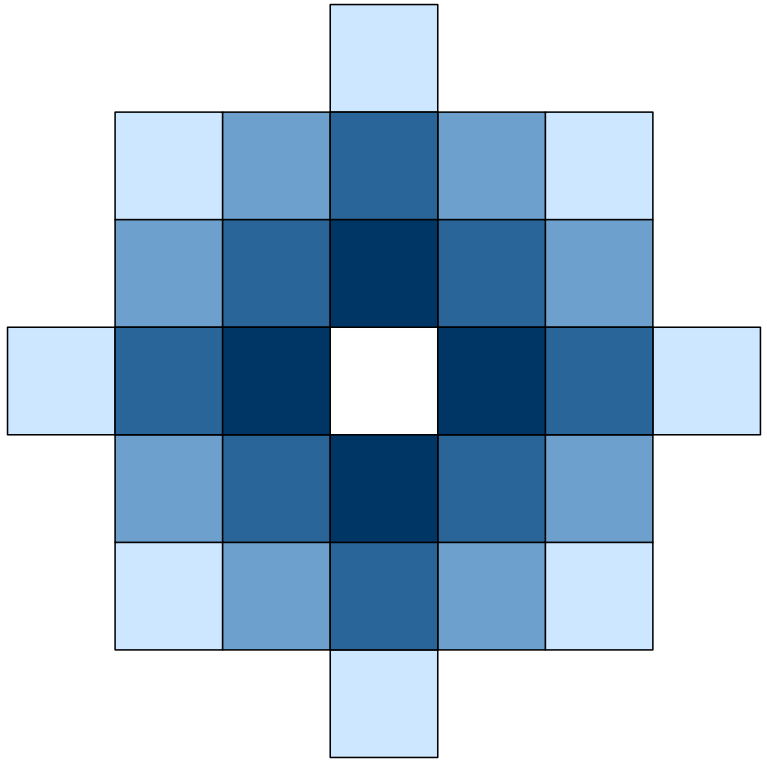
- Contiguity

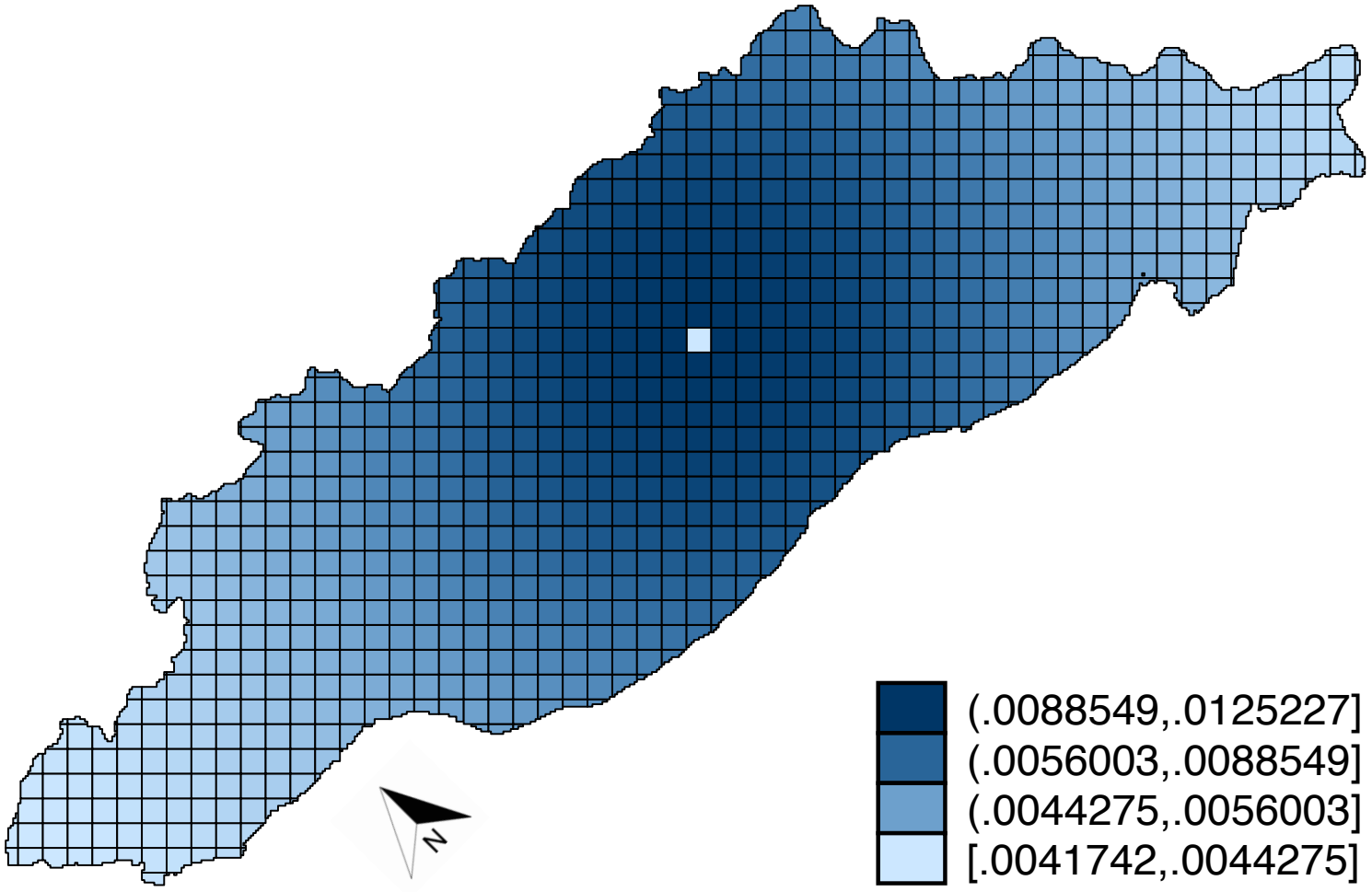




Spatial Weighting Matrices

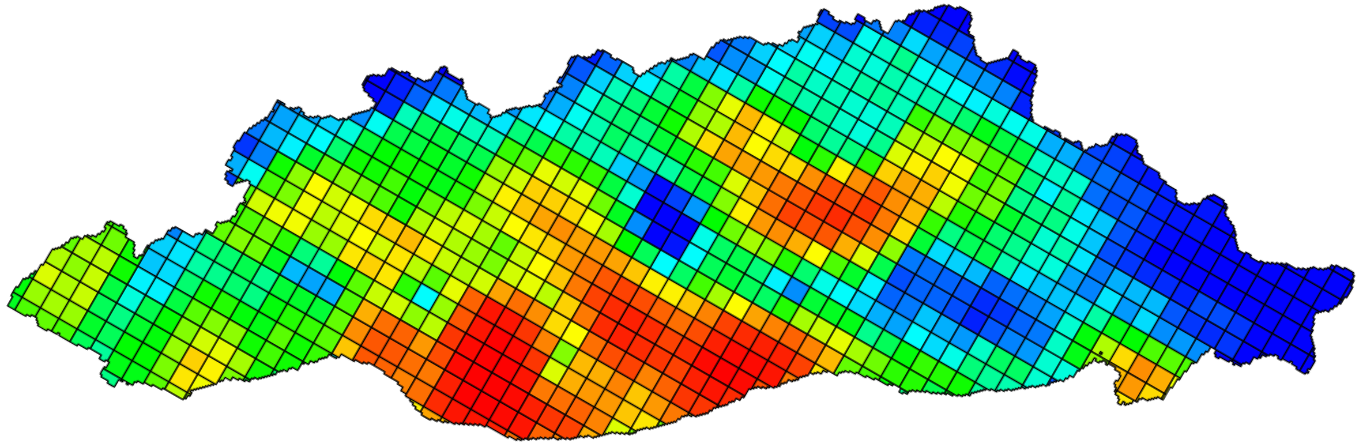
- Inverse Distance



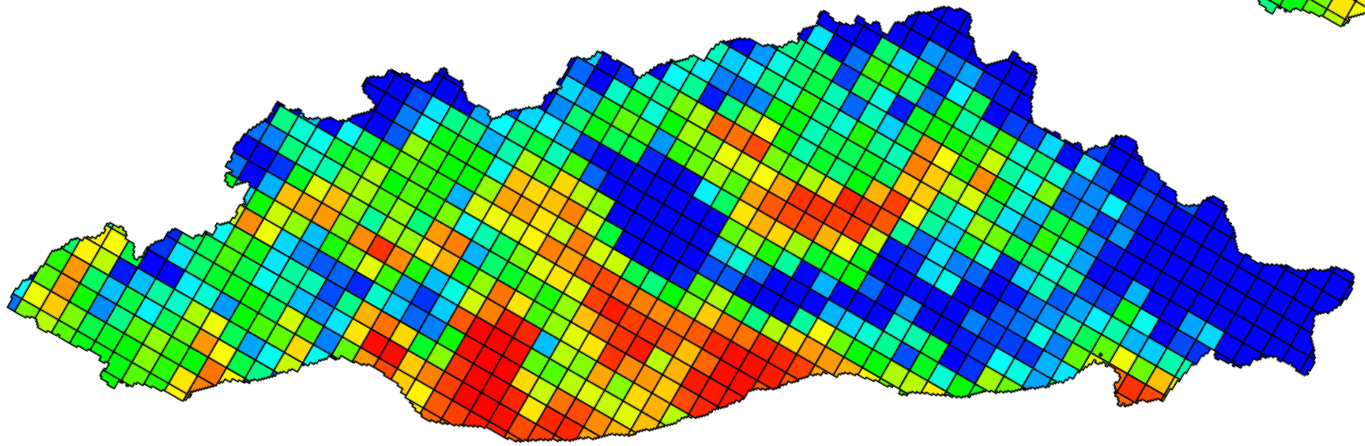


Spatial Weighting Matrices

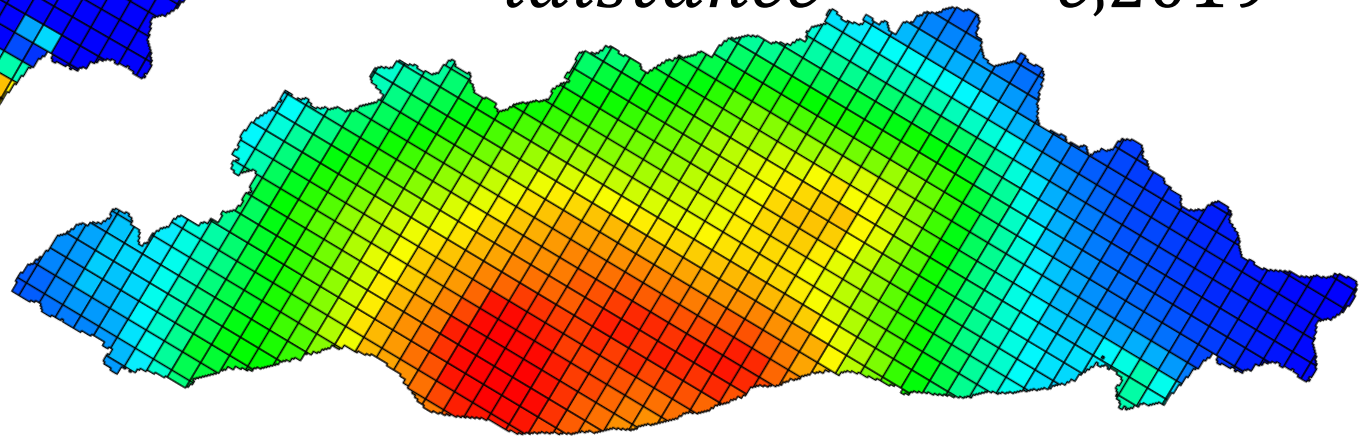
$W_{contiguity} \times IRR_{c,2019}$

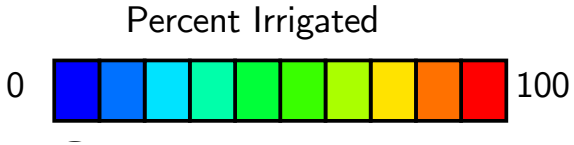


$IRR_{c,2019}$



$W_{idistance} \times IRR_{c,2019}$





Spatial Durbin Model (SDM)

$$CONFLICT_{c,i,t} = \beta_0 + \sum_{k=0}^{2} \beta_{1k} SPEI_{c,t-k}$$ → Lagged drought index

$$+\beta_2 IRR_{c,t}$$ → Irrigation

$$+\beta_3 X_c$$ → Cross-sectional controls

$$+\beta_4 L_t$$ → Time period controls

$$+CONFLICT_{c,i,t-1}$$ → 1-year lag of dependent variable

$$+\rho W \times CONFLICT_{c,i,t}$$

$$+\sum_{k=0}^{2} \theta_{1k} SPEI_{c,t-k} \times W$$

$$+\theta_2 IRR_{c,t} \times W$$

$$+\theta_3 X_c \times W$$

→ Spatially autoregressive terms (dependent variable, drought index, irrigation, cross-sectional controls)

$$+\mu_i \tau$$ → District time trend

$$+\gamma_t$$ → Year fixed effect

$$+\varepsilon_{c,i,t}$$ → Error term

SDM Identification

- Identification Assumption: in the absence of irrigation, cell-level outcomes would have followed the same path over time in cells that receive irrigation in different years, conditional on controls and fixed effects.

Endogeneity of Irrigation Investments

- Areas that receive irrigation may also:
  - Be politically connected
  - Have higher potential agricultural productivity
  - Have lower levels of conflict
- Solution:
  - Restrict sample to only include cells that receive irrigation at some point during the study period

Spatially Autoregressive Instrumental Variables (SAR-IV)

$$CONFLICT = \beta_0 + \pi_1 IRR + \beta_1 X + \theta_1 X \times W + \lambda W \times CONFLICT + u$$

- $\pi_1 IRR$ → Irrigation instrumented with topography
- $\beta_1 X$ → Cross-sectional controls
- $\theta_1 X \times W$ → Spatially lagged control variables
- $\lambda W \times CONFLICT$ → Spatially lagged dependent variable
- u → Spatially lagged error term

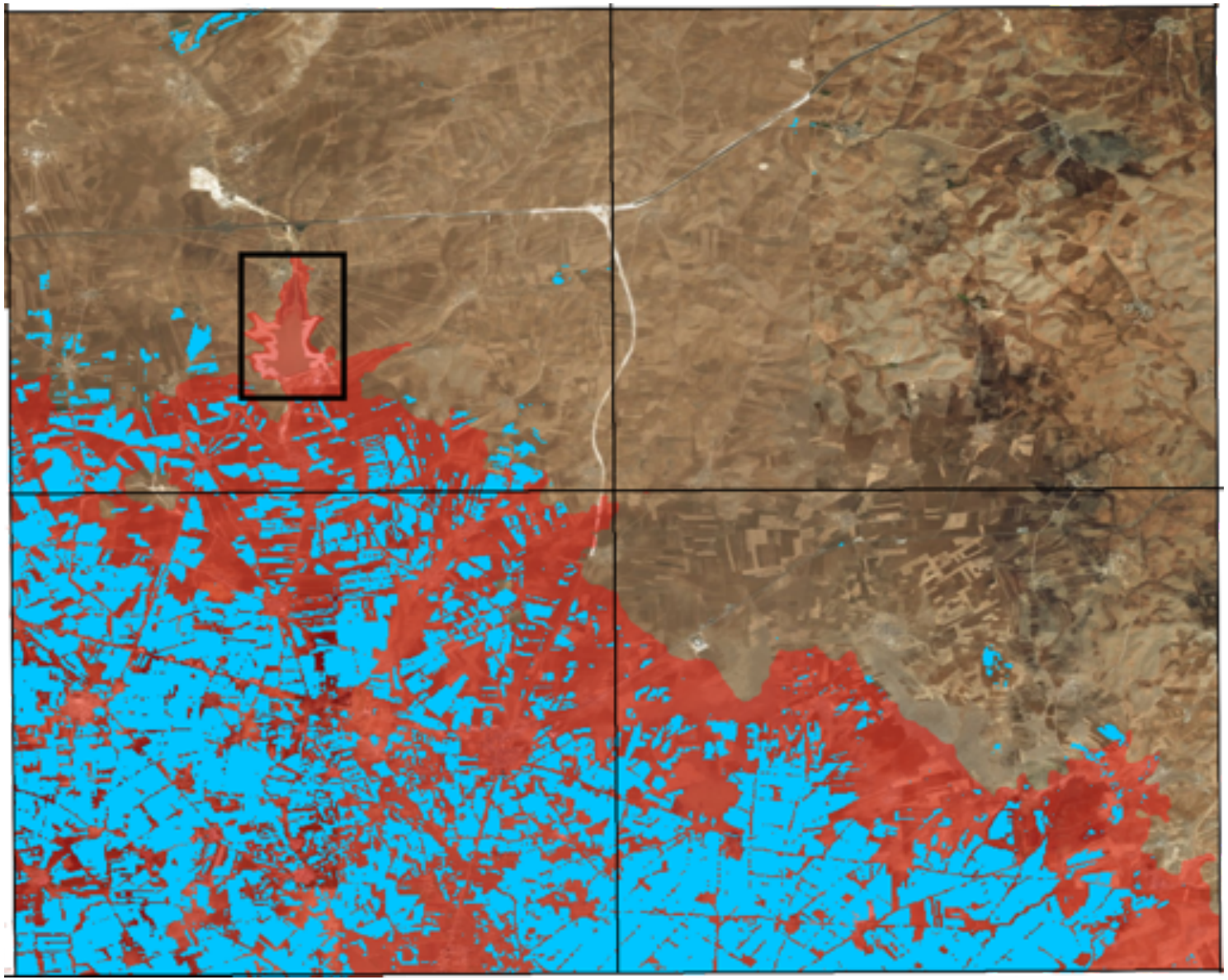
$$u = \rho W u + \varepsilon$$

Instrument

- Irrigation eligibility criteria:
  1. Below distributary dam
  2. Relatively flat
- Instrument:

$$\ln(altitude_c \times (1 + slope_c))$$

- Why interact?
  - Just altitude:
    - Dams are at different altitudes
  - Just slope:
    - High plateaus above dams

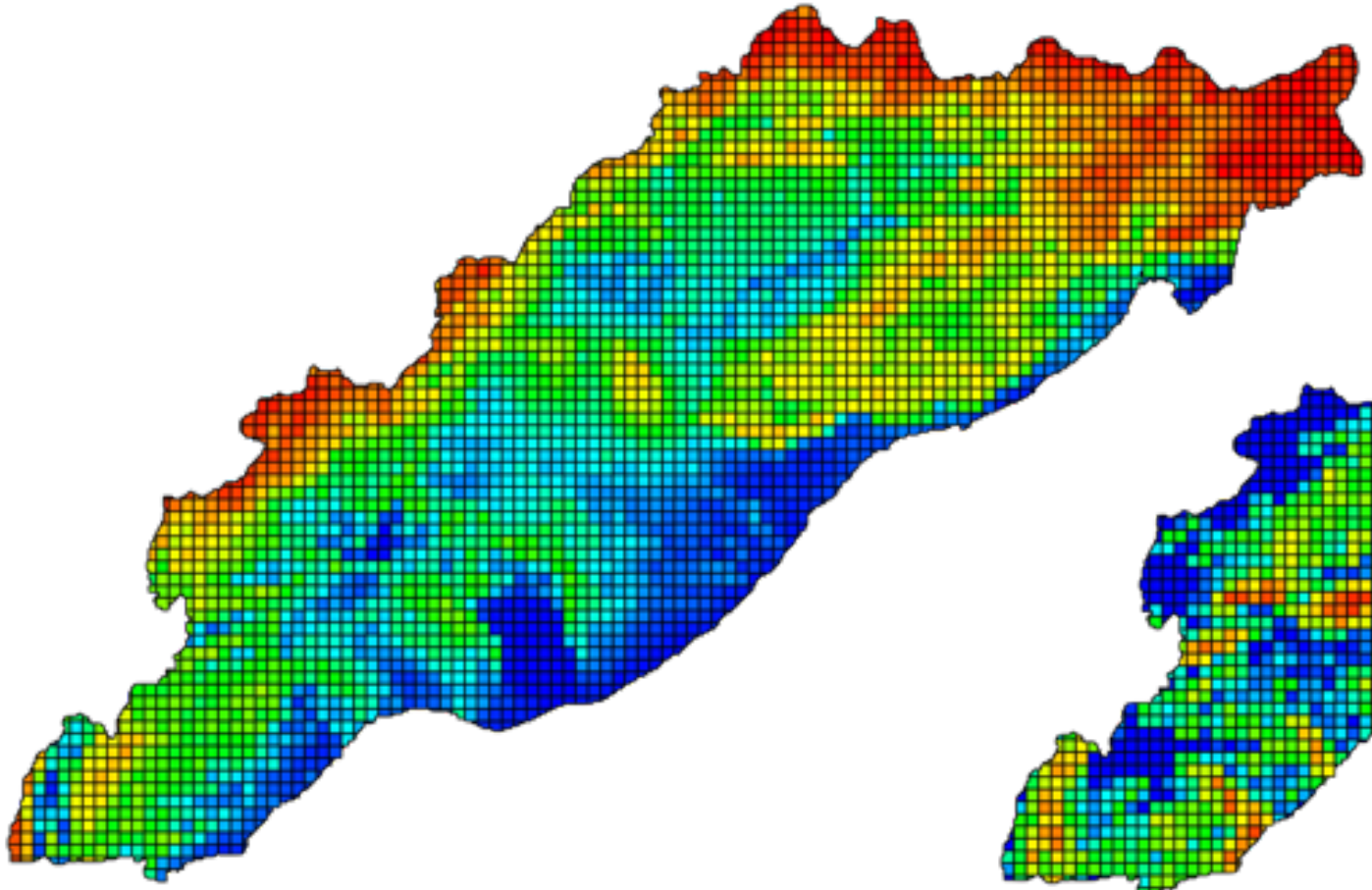


SAR-IV Identification

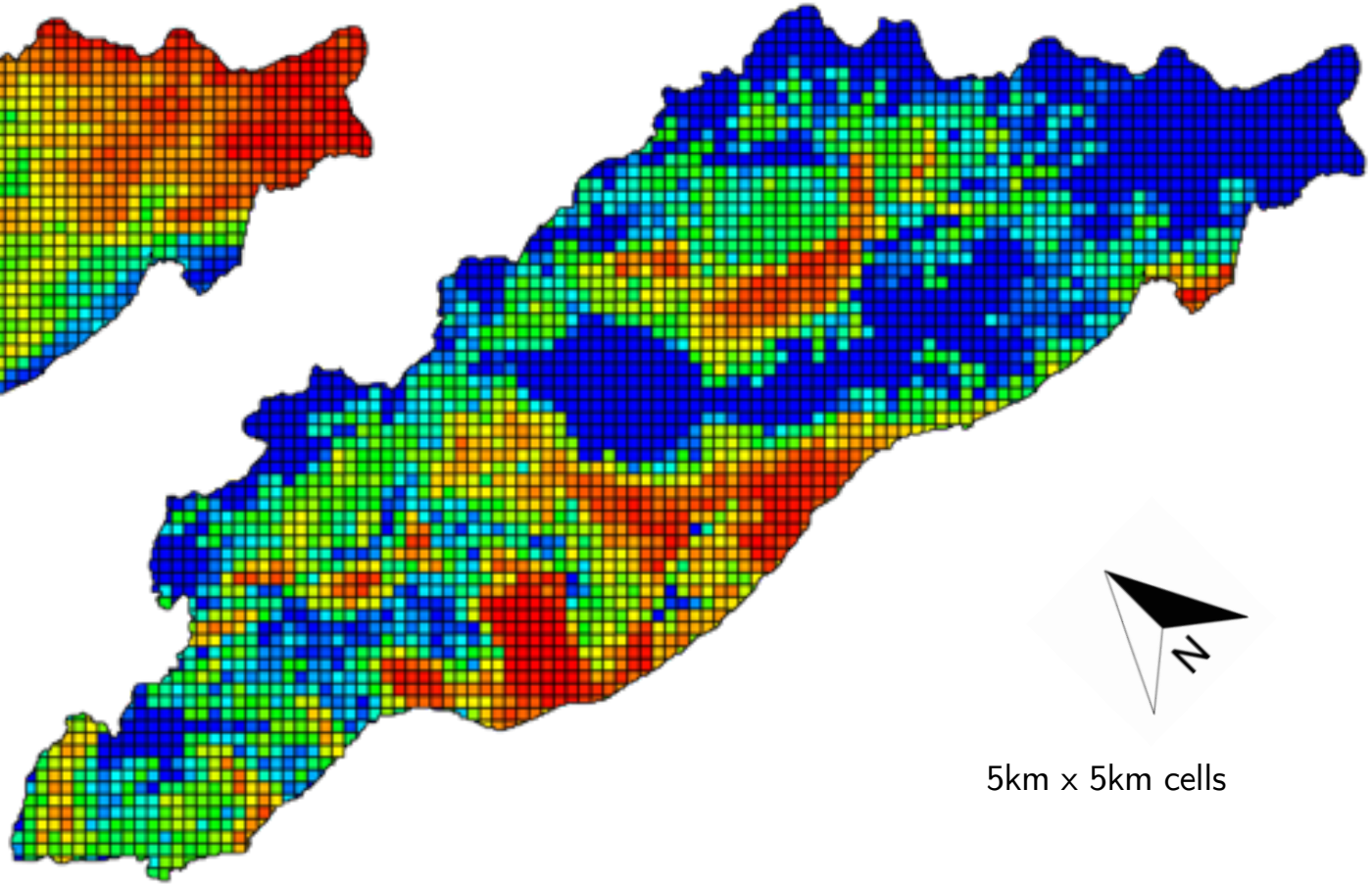
- Relevance:
  - Topography affects the potential of exposure to irrigation (instrument is not weak)
- Exclusion:
  - Topography only affects conflict by determining geographic eligibility for irrigation

Terrain Instrument and Irrigation

$\ln(altitude_c \times (1 + slope_c))$



$\ln(IRR_c)$



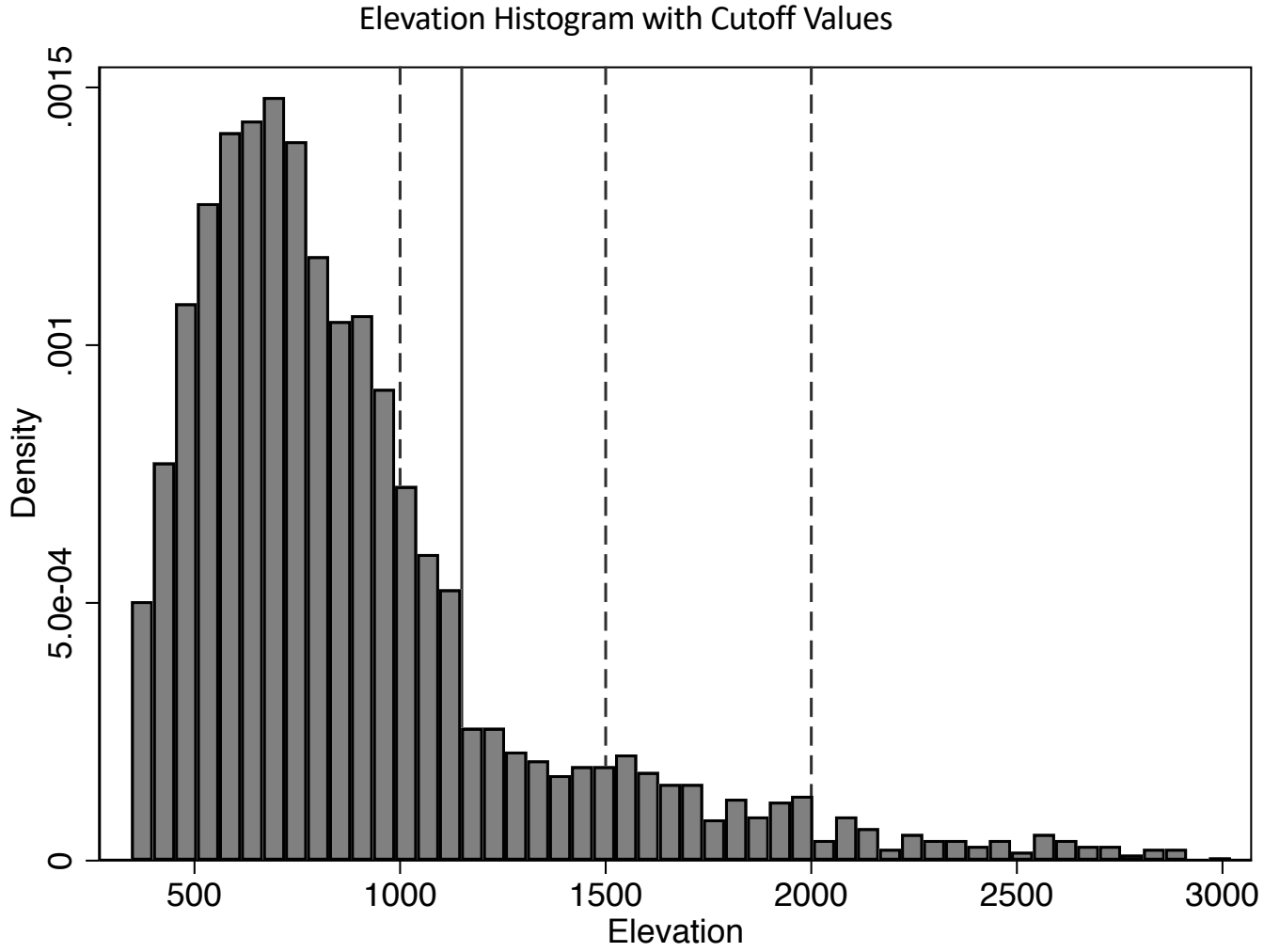
5km x 5km cells

Exclusion Restriction

- Topography only affects conflict through irrigation?
- Violated by the fact that most PKK bases are in the mountains.
- Solution: set elevation cutoff to exclude mountainous areas

SAR-IV Geographic Restrictions

- Solid line: 1100m, where mountains begin. This is the optimal geographic restriction.
- Dashed lines: alternative geographic restrictions for robustness
  - 1000m
  - 1500m
  - 2000m



4. Results

Panel Models

- The probably of conflict incidence decreases by 2.1% following the introduction of irrigation
  - Effect strengthened when sample is restricted to treatment group
- Positive association between conflict and road cover, elevation, population
- Negative association with AKP strongholds

Table 1: Conflict Incidence and Irrigation, Panel

	(1) OLS HAC I	(2) Durbin I	(3) OLS HAC II	(4) Durbin II
Post Irrigation	-0.0189***	-0.0114***	-0.0221***	-0.0212***
	(0.00637)	(0.00420)	(0.00733)	(0.00463)
Treatment	-0.00820	-0.00179		
	(0.00849)	(0.00443)		
Y_{t-1}		0.412***		0.261***
		(0.0182)		(0.0472)
W x Y		-0.00301		-0.00940*
		(0.00203)		(0.00499)
Population	0.00558***	0.00700***	0.000108	-0.000348
	(0.00203)	(0.000780)	(0.00240)	(0.000798)
AKP voteshare	-0.00110***	-0.00103***	-0.000182	-0.000273**
	(0.000361)	(0.000117)	(0.000365)	(0.000129)
HDP voteshare	0.000950*	-0.000691***	-0.000213	0.000208
	(0.000522)	(0.000186)	(0.000706)	(0.000341)
Tribal	0.00939	0.000799	-0.0233	-0.00989
	(0.0155)	(0.00400)	(0.0194)	(0.00743)
Nightlights Change	0.00522	0.00393***	-0.0147	-0.00747
	(0.00635)	(0.00110)	(0.0120)	(0.00472)
Nightlights Level	0.00330	0.000531	0.0208**	0.0110***
	(0.00420)	(0.000694)	(0.00812)	(0.00349)
Roads	0.00177**	0.000995***	0.00817	0.00616***
	(0.000863)	(0.000227)	(0.00541)	(0.00111)
SPEI	-0.00313	-0.00458	-0.00291	0.0213**
	(0.00360)	(0.0108)	(0.00810)	(0.0108)
Slope	0.00392***	-0.000748	0.00408	0.00280*
	(0.000899)	(0.000473)	(0.00365)	(0.00160)
Elevation	1.09e-05	2.47e-05***	8.52e-05**	6.89e-05**
	(1.46e-05)	(7.32e-06)	(4.14e-05)	(3.23e-05)
Area	0.000412***	-0.000133**	0.000401**	0.000204***
	(0.000125)	(5.59e-05)	(0.000192)	(7.76e-05)
Observations	26,370	25,491	7,170	6,931
Year FE	X	X	X	X
Cell Specific Time Trend	X		X	
District Specific Time Trend		X		X
Only Treated Cells			X	X

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

Alternative Measures

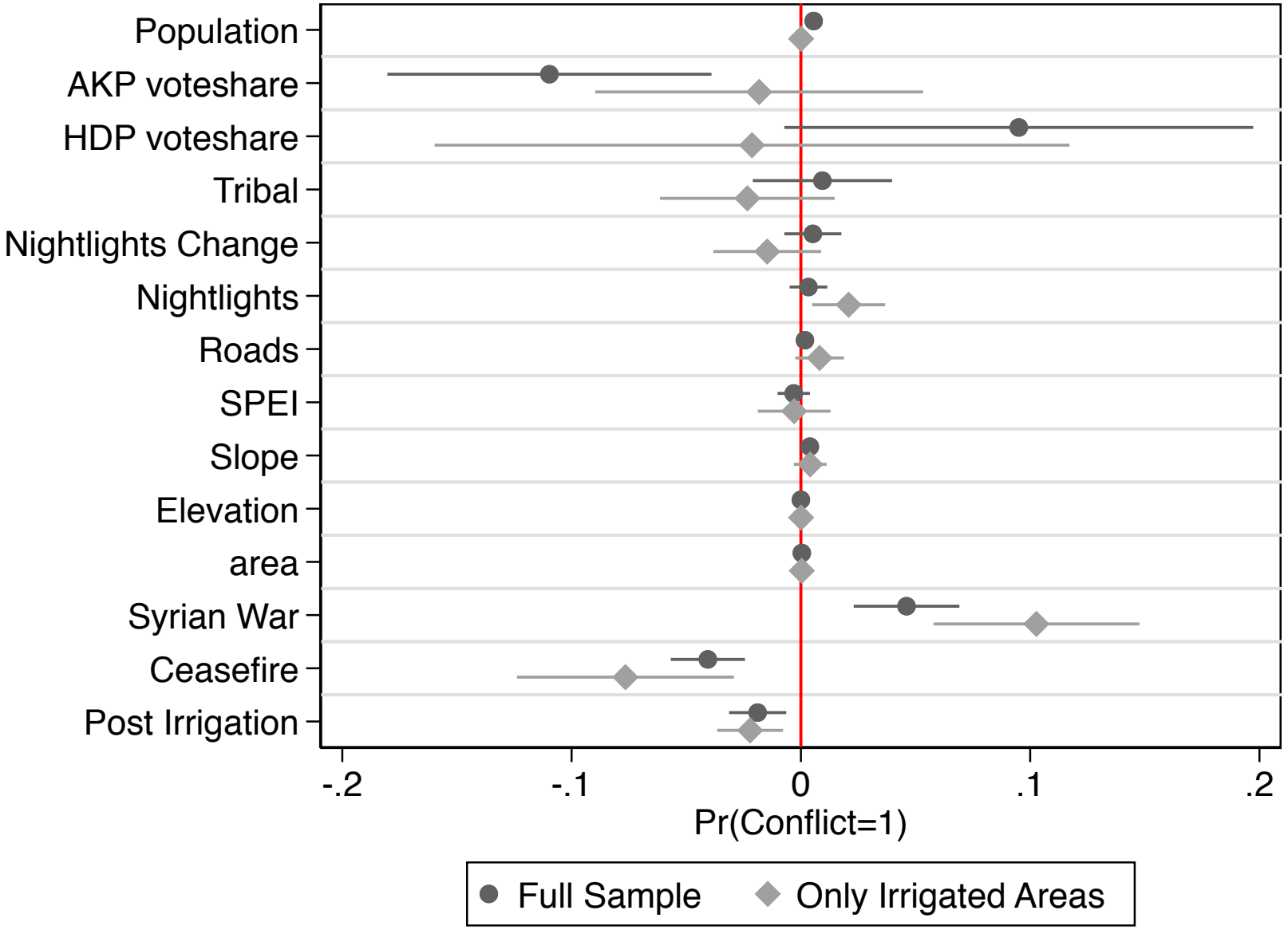
- Effect persists despite changing the dependent variable and the measure of irrigation
- For each successive year of irrigation:
  - probability of conflict decreases by 0.2%
  - Probability of recruitment decreases by .07%
- For each additional square kilometer of irrigation in a cell:
  - probability of conflict decreases by 0.05%
  - Probability of recruitment decreases by .03%

Table 2: Alternative Measures of Irrigation and Conflict and Irrigation, Panel

	(1) UCDP	(2) UCDP	(3) Recruitment	(4) Recruitment
Irrigated Area		-0.000539***		-0.000387**
		(0.000165)		(0.000155)
Years Since Irrigation	-0.00202***		-0.000756***	
	(0.000387)		(0.000250)	
Y_{t-1}	0.2641484***	0.1356849***	0.1353034***	0.1354276***
	(0.0471131)	(0.0404086)	(0.0404087)	(0.0403218)
W x Y	0.0093332*	0.0090328	0.0090235	0.0089834
	(0.0050431)	(0.0069437)	(0.0069471)	(0.0069424)
Population	-0.000444	-0.000558	0.000966	0.00110
	(0.000798)	(0.000783)	(0.00106)	(0.00106)
AKP voteshare	-0.000286**	-0.000225*	-0.000349**	-0.000365**
	(0.000129)	(0.000133)	(0.000162)	(0.000163)
HDP voteshare	0.000266	0.000448	0.000130	0.000157
	(0.000343)	(0.000344)	(0.000428)	(0.000427)
Tribal	-0.00827	-0.0154**	-0.00332	-0.00470
	(0.00747)	(0.00768)	(0.00593)	(0.00620)
Nightlights Change	-0.00766	-0.00772	-0.00497	-0.00494
	(0.00472)	(0.00472)	(0.00337)	(0.00337)
Nightlights	0.0112***	0.0111***	0.00533**	0.00524**
	(0.00349)	(0.00349)	(0.00249)	(0.00248)
Roads	0.00616***	0.00631***	0.00180**	0.00186**
	(0.00111)	(0.00113)	(0.000752)	(0.000756)
SPEI	0.0177*	0.0194*	-0.000946	0.000255
	(0.0105)	(0.0104)	(0.0105)	(0.0106)
Slope	0.00273*	0.00148	0.00145	0.00111
	(0.00161)	(0.00156)	(0.00169)	(0.00171)
Elevation	6.62e-05**	6.10e-05*	7.46e-06	-5.22e-07
	(3.29e-05)	(3.32e-05)	(3.29e-05)	(3.34e-05)
Area	0.000220***	0.000274***	0.000180***	0.000201***
	(7.75e-05)	(8.18e-05)	(6.99e-05)	(7.31e-05)
Observations	6,931	6,931	6,453	6,453
Only Treated Cells	X	X	X	X

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

OLS HAC Estimates

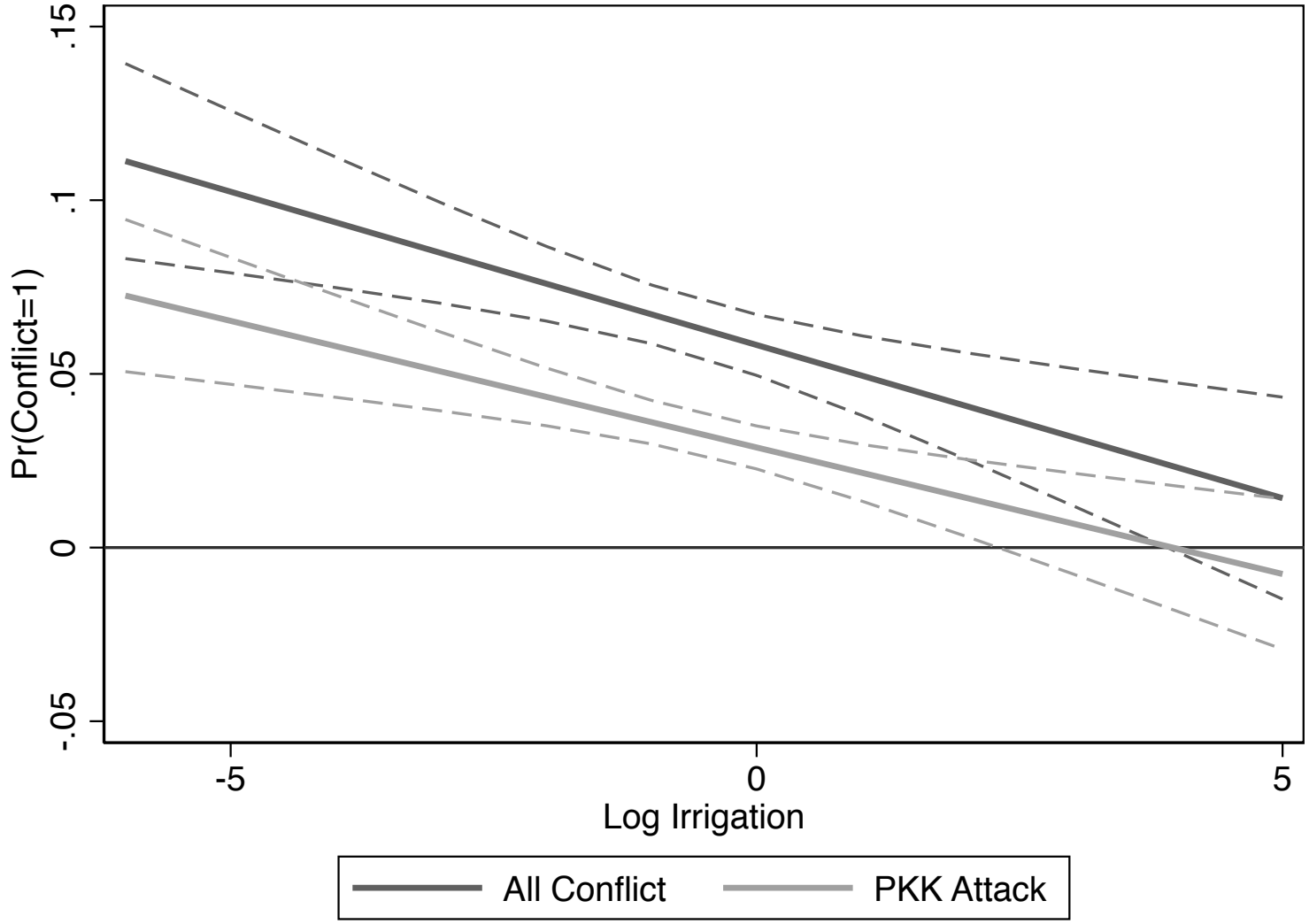


Discussion

- Absolute marginal effect of irrigation appears small– only 2% reduction in the probability of conflict incidence
  - This is because the baseline probability of experiencing conflict in a given cell-year is also small-- roughly 3%
- But, for the full sample the effect of receiving irrigation is roughly half as strong as the effect of a ceasefire.

Effect of irrigation on conflict incidence (SAR-IV)

- Probability of conflict:
  - Baseline: 6.7%
  - No irrigation: 11.1%
  - Fully irrigated: 1.4%
- Probability of PKK attack:
  - Baseline: 3.6%
  - No irrigation: 7.2%
  - Fully irrigated: -0.7%



Discussion

- Between 2016 and 2019, a village in a fully irrigated area was
  - 4.7 times less likely to experience at least one conflict event than a random village.
  - 7.9 times less likely to experience at least one conflict event than a village in a non-irrigated area
- However, the baseline likelihood of experiencing conflict in this area is generally low to begin with.

Robustness

- Panel SDM
  - Change dependent variable from conflict incidence to recruitment
  - Change measure of irrigation
    - Years since irrigation was introduced
    - Proportion of cell irrigated
- Cross-Sectional SAR-IV
  - Change weighting matrix
    - Inverse distance
  - Geographic restrictions
  - Restrict ACLED conflict incidence to PKK attacks

Potential mechanisms

- Collier and Hoeffler (1998) "opportunity cost of rebellion"?
  - The effect of irrigation persists after controlling for economic development (Nightlights growth)
  - Irrigation affects income, but also perception of the government

- Smallholder interviewed in Suruç:
  - "In the old days, we could not even produce 100 kilos of wheat. Some years there was drought, we could grow nothing and there would be famine. Now, we export wheat, we grow cotton, we have money for equipment and tractors. [...] We do not forget who dug the canals."

5. Conclusion

Caveats

- Despite consistently negative effect of irrigation on conflict incidence and recruitment, GAP alone cannot hope to "solve" Kurdish conflict.
  - Many of the PKK's grievances involve regional economic disparities, but more involve social, cultural, and political factors unaffected by soil moisture
  - Indeed, GAP has caused new grievances including the recent flooding of Hasankeyf and increased rural inequality

Key findings and their implications

- Consistent negative association between irrigation and conflict/recruitment
- Strong negative relationship between nightlights growth and conflict
- Conflict in the year t-1 increases the likelihood of experiencing conflict in year t by 26%.
  - Where heavy handed military tactics are employed, "the perception of the government's legitimacy declines, the insurgent movement wins over the populace's heart" (Ünal, 2012: 449).
- Carrots are more effective than sticks

Contributions

- Methodological
  - Understanding conflict dynamics, gathering bespoke data thereon, and building models accordingly to prevent spurious results
    - **Cross-country FE regressions are still the norm** in econometric approaches to the study of conflict.
    - The coefficients of the control variables are themselves very useful for interpreting the main result and understanding the conflict as a whole
- Empirical
  - Significant debate in Turkey regarding the effect of GAP on PKK conflict, but near complete lack of evidence.
  - Findings have implications for countries where development projects are being conducted in conflict areas
    - E.g. Pakistan, Ethiopia, China, etc.

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