The Direct Impact of Economic Growth on Temperature

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Motivation

While economic growth drives global warming through CO_2 emissions, it may also **directly alter local temperatures** through:

- **Land Cover change:** Deforestation, urbanization, irrigation
- **Aerosol Pollution:** Industrial particles affecting albedo
- **Anthropogenic Heat:** Direct thermal emissions from economic activity

Research Question: How much does local economic growth contribute to local warming, independent of global CO_2 effects?

Novel Contribution

Beyond existing urban heat island studies:

- **Global scope:** Entire planet, not just selected cities
- **Growth dynamics:** Economic change over time, not static comparisons
- **Rural inclusion:** All development effects
- **Causal design:** Natural experiments vs. correlational evidence
- **High resolution:** 30+ years of satellite data at 500m grid

Conceptual Framework

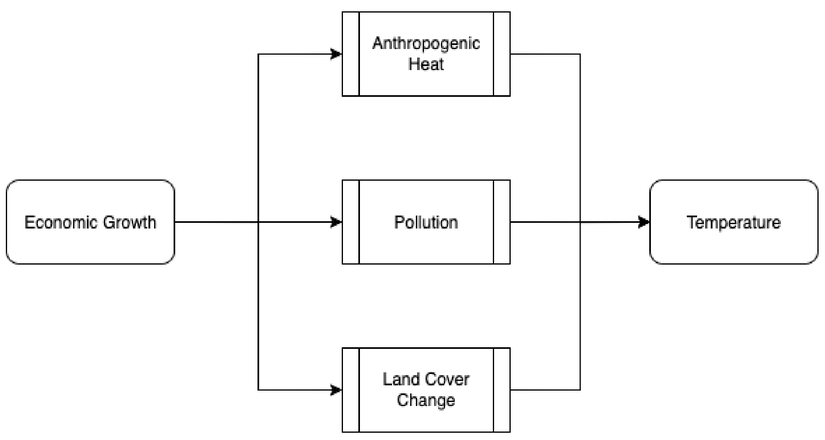


Figure: Economic growth → Local temperature through multiple biophysical channels, distinct from global CO_2 pathway.

Key Innovation

Causal Identification Strategy:

- **Two-way fixed-effects models:** Account for space- and time-invariant confounders and isolate year-over-year relationship
- **Political favoritism:** Leaders' birthplaces receive preferential investment
- **Resource discoveries:** Giant oil/gas finds create exogenous growth shocks

Potential Policy Relevance

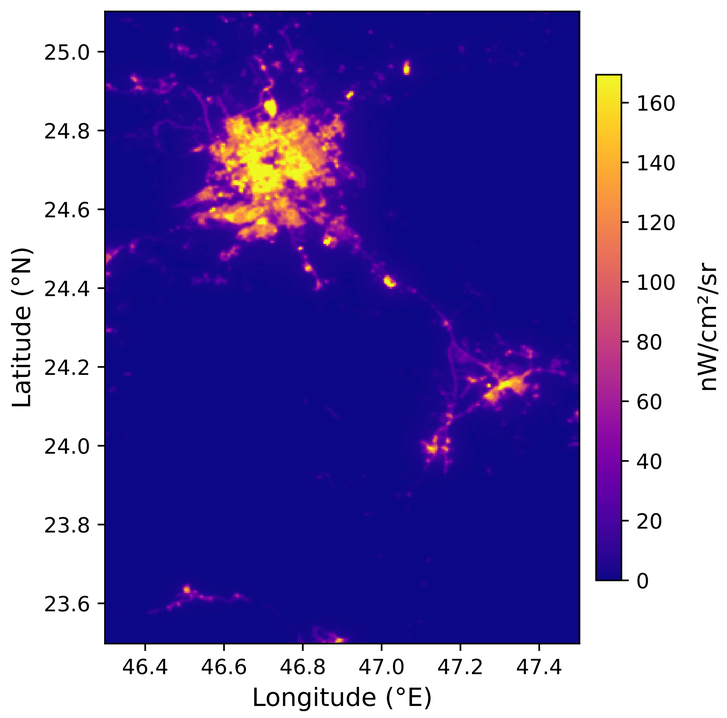
If causal effects are confirmed, findings could inform:

- Understanding the full climate costs of economic development
- Research on urban planning and industrial zoning decisions
- Future studies linking local temperature changes to human outcomes

Project Status & Timeline

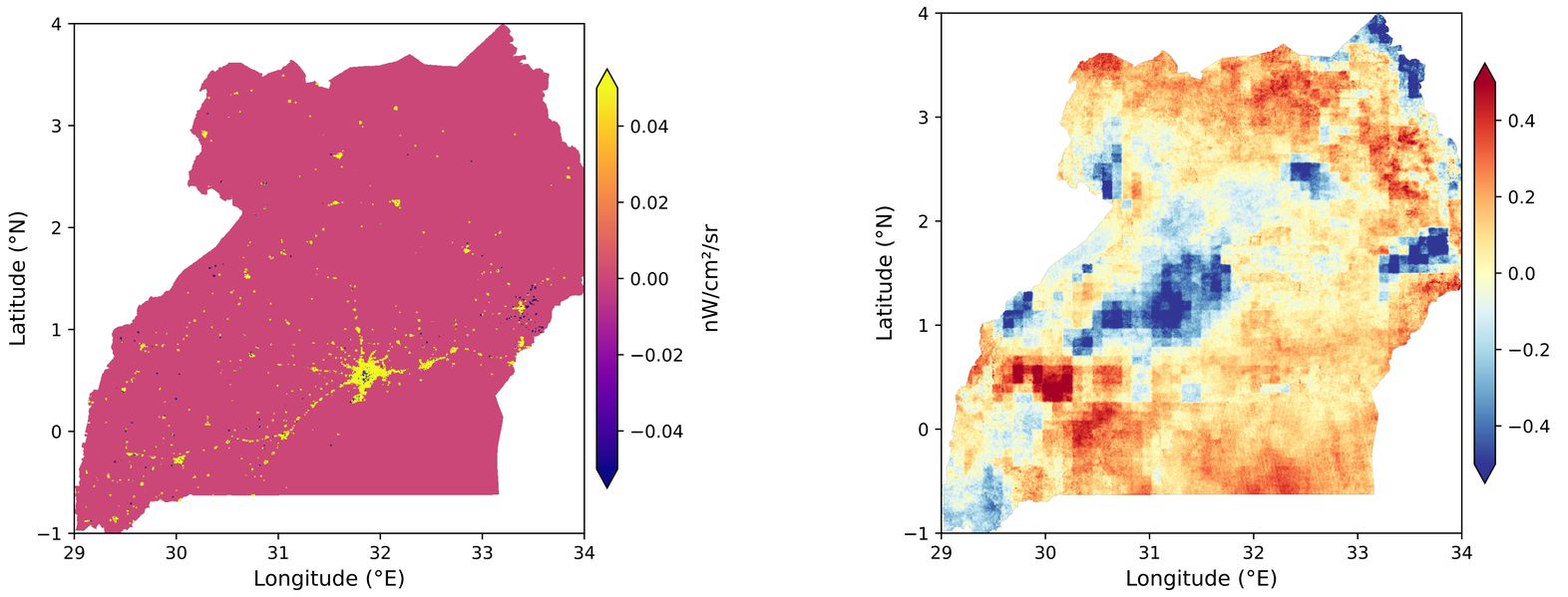
Completed: Global data harmonization, pilot results
In Progress: Full-scale estimation
Next Steps: Welfare impacts, mechanism analysis

Pilot Case Studies



(a) Nighttime Radiance (b) Land Surface Temperature

Figure: **Economic Development and Temperature for Riyadh, Saudi Arabia.** Spatial correlation between (a) nighttime light intensity from VIIRS satellite data and (b) land surface temperature from MODIS thermal infrared observations. The analysis reveals characteristic heat island patterns where areas of high urban light intensity correspond to elevated surface temperatures. Data: VIIRS 2012 annual composite, MODIS LST median 2012.



(a) Nighttime Radiance (b) Land Surface Temperature

Figure: **2012/2013-2018/2019 Long-Difference Economic Growth and Temperature for Uganda**: Spatial correlation between economic development and temperature change in Uganda from 2012 and 2013 to 2018 and 2019. (a) Nighttime radiance proxies change of urban development. (b) Land surface temperature illustrates temperature changes across the same region. Data: VIIRS annual composites, MODIS LST median.

Table: **Preliminary results: Economic development increases local temperatures in Uganda, 2012–2019.** Fixed-effects panel regression with over 10 million grid-cell observations shows that nighttime radiance (proxy for economic activity) significantly increases land surface temperature. The estimated coefficient of 0.0305K suggests that moving from darkness to mean radiance levels (1.69 nW/cm²/sr) increases local temperature by 0.05K, while highly developed areas like central Kampala (radiance: 78) experience warming of 2.4K relative to undeveloped areas. Two-way fixed effects control for time-invariant cell characteristics and common year shocks, isolating within-cell variation over time. Standard errors clustered by political subdivision.

	Coef.	Std. Err.	z	P> |z|	[0.025	0.975]
Intercept	2.91×10^{-11}	9.29×10^{-12}	3.129	0.002	1.09×10^{-11}	4.73×10^{-11}
VIIRS radiance	0.0305	0.010	3.082	0.002	0.011	0.050
No. Observations	10,105,344					

Methodology

$$T_{it} = \alpha + \beta \cdot \text{NightLights}_{it} + \gamma_i + \delta_t + \lambda_i \cdot t + \epsilon_{it}$$

- **Sample:** Global 500m × 500m grid cells, 1992–2022 (18B+ observations)
- **Dependent Variable:** Annual median land surface temperature (LST)
- **Key Explanatory Variable:** Nighttime radiance intensity
- **Data Sources:**
  1. **Economic Activity:** DMSP-OLS (1992–2013) & VIIRS-DNB (2012–2022)
  2. **Temperature:** AVHRR & MODIS LST from GLASS product
- **Fixed Effects:** Grid cell (γ_i), year (δ_t), cell-specific trends ($\lambda_i \cdot t$)
- **Standard Errors:** Two-way clustered by grid cell and country-year
- **Causal Identification:**
  1. **Regional favoritism:** Exploit quasi-random variation in growth from political connections (Hodler & Raschky, 2014)
  2. **Resource discoveries:** Use giant oil/gas field discoveries as exogenous growth shocks (Arezki et al., 2017)

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Modelling and Simulations