

Climate change and agricultural suicides in India

Kamal Kumar Murari^a, T. Jayaraman^{a,1}, and Madhura Swaminathan^b

Carleton (1) claims that “temperature during India’s main agricultural growing season has a strong positive effect on annual suicide rates.” Using state-scale panel data for 1967–2013, the author suggests that an increase in 1 °C temperature in a single day can cause ~70 suicides. The evidence, she argues, is consistent with “an agriculture channel in which heat damages crops,” resulting in economic hardship and suicide.

There are flaws in the data and assumptions used by Carleton (1).

The data on deaths from suicide are from the National Crime Records Bureau. The problem of underreporting in data from police records is recognized, though not that the degree of underreporting may vary across states and time. There are serious concerns about the consistency of data before 1995 (2). Carleton (1) has used state-level suicide data, that is, data for urban and rural areas combined of a state. Can one relate the rate of urban suicides to climatic factors?

The second dependent variable is crop yield measured in value terms (rupees per hectare per year at fixed 1960–1965 prices) for an index of major crops (rice, wheat, sugar, sorghum, millet, and maize). Cotton, a major crop in the regions with concentrations of farmer suicides, is excluded.

The two main independent variables are cumulative rainfall and temperature. For temperature, the variable, daily degree days, is defined as the difference between actual and threshold temperature. Notwithstanding sensitivity analysis, the assumption of a temperature threshold of 20 °C is inappropriate.

Every crop has a specific temperature threshold, ranging from 33 °C to 38 °C, above which a negative impact on yields is possible (3). Indeed, temperatures in the range of 20 °C to 29 °C are viewed as favorable for crop growth (4, 5).

The assumption of growing (June to September) and nongrowing seasons (rest of the year) is incorrect. India has two major growing seasons, the monsoon and the winter season. Research indicates that crop yields are most sensitive to temperature variations in the latter (6). Not separating the winter crop season from the other months of the year is an error.

The author finds a strong positive coefficient when aggregate state-level deaths from suicide are regressed on degree days in the growing season. The quality of data on suicides is in doubt, and the definitions of temperature threshold and growing season are incorrect. The author refers to robustness checks but retains the erroneous assumptions. Without further study, it is not clear how we interpret the observed coefficient.

Results on the negative effect of temperature on crop yields are not tenable. Of the six crops pooled, rice is mainly a monsoon crop, wheat is a winter crop, and sugarcane is a 12- to 18-mo crop. How can the July–September temperature explain changes in the combined yields of these crops? The author ignores the literature on crop-specific effects of temperature on yield (3, 5).

The data and their interpretation do not support claims of a temperature-related agricultural explanation for farmer suicides, an outcome of multiple factors.

1 Carleton TA (2017) Crop-damaging temperatures increase suicide rates in India. *Proc Natl Acad Sci USA* 114:8746–8751.

2 Nagaraj K, Sainath P, Rukmani R, Gopinath R (2014) Farmers’ suicide in India: Magnitudes, trends, and spatial patterns, 1997–2012. *Rev Agrar Stud* 4:53–83.

3 Lou Q (2011) Temperature thresholds and crop production: A review. *Clim Change* 109:583–598.

4 Schlenker W, Roberts MJ (2009) Nonlinear temperature effects indicate severe damages to U.S. crop yields under climate change. *Proc Natl Acad Sci USA* 106:15594–15598.

5 Hatfield JL, Prueger JH (2015) Temperature extremes: Effect on plant growth and development. *Weather Clim Extrem* 10:4–10.

6 Lobell DB, Sibley A, Ortiz-Monasterio JI (2012) Extreme heat effects on wheat senescence in India. *Nat Clim Chang* 2:186–189.

^aCenter for Climate Change and Sustainability Studies, School of Habitat Studies, Tata Institute of Social Sciences, Mumbai, Maharashtra 400088, India; and ^bEconomic Analysis Unit, Indian Statistical Institute, Bangalore 560059, India

Author contributions: K.K.M., T.J., and M.S. wrote the paper.

The authors declare no conflict of interest.

Published under the [PNAS license](#).

¹To whom correspondence should be addressed. Email: tjayaraman@tiss.edu.