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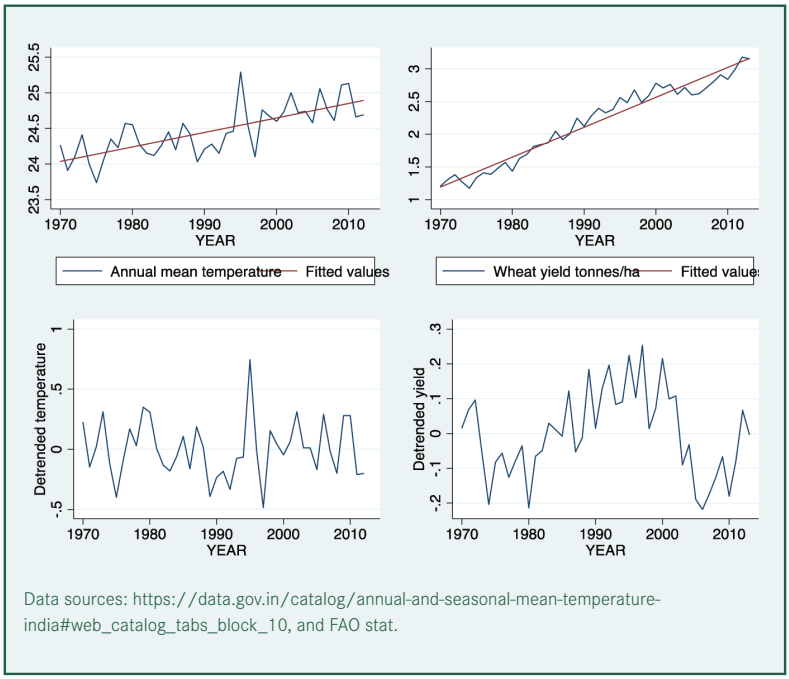
What do economists have to say about climate impacts on South Asia?

Global warming has changed the climate in South Asia. Studies by SANDEE researchers and others show that this warming has significantly decreased crop production and manufacturing output in the region. The findings are sobering. In India, the average temperature has risen by 0.8 degrees C in the last 45 years, contributing to a likely 10% decrease in rice production relative to trend.

South Asia's changing climate has had many different impacts including changes in ecosystems, more severe storms, rainfall that is more concentrated in a few days per year leading to more floods and more droughts, deaths from heat waves, crop losses, and reduced labor productivity in manufacturing. These have been studied by researchers in many different disciplines. In particular, economists have contributed to studies on the effects of warming on crop yields and on labor productivity.

Due to global warming, the climate in South Asia has changed. For example, in India, the average temperature has risen by 0.8 degrees C in the last 45 years (Figure 1, top left).



Data sources: https://data.gov.in/catalog/annual-and-seasonal-mean-temperature-india#web_catalog_tabs_block_10, and FAO stat.

Fig 1: Temperature and wheat yields in India

There are, broadly speaking, two kinds of econometric studies of the effects of climate change on crop yields. The first, the Ricardian approach, uses the fact that different districts have different climates and, therefore, different yields and farm profits, to infer the effect of a hotter climate on crop production. For example, K. S. Kavi Kumar (SANDEE WP 45-09) found that climate change is predicted to reduce the value of farm output by 3% by 2070-99. One difficulty with the Ricardian approach is that it is vulnerable to the general problem of confounding: Hotter districts may also be drier, have sandier soils, or be more likely to be irrigated. Then the correlation between temperature and yield may be spurious. For this reason, econometricians include such variables on the right-hand side of their regressions as control variables to account for their effects. But finding data on all the variables that may be relevant is no easy task.

Seeking a way around this problem, economists have turned to the use of panel data that uses variation in climatic variables and crop yields over time. This method uses

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SANDEE

The South Asian Network for Development and Environmental Economics (SANDEE) is a regional network that seeks to bring together analysts from the different countries in South Asia to address their development-environment problems. Its mission is to strengthen the capacity of individuals and institutions in South Asia to undertake research on the inter-linkages among economic development, poverty, and environmental change, and to disseminate practical information that can be applied to development policies. SANDEE's activities cover Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka.

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the fact that both the climate and yields vary from year to year to infer the impact of the former on the latter. However, while the climate has been getting hotter, crop yields have been rising due to capital investments and technological progress (Figure 1, top right). In order to know whether the climate has impacted them, the data have to be de-trended, that is the trends in the variables have to be subtracted from the variables themselves. The *de-trended* variables (blue curves minus red lines) are shown in the bottom of Figure 1. The final step is to calculate the extent to which the yield goes down when the temperature goes up. This is illustrated in Figure 2.

Figure 2 shows that the de-trended wheat yield tends to be positive when the de-trended temperature is negative – suggesting a negative effect of temperature on wheat yields in India. The illustration in Figure 2 uses a single time series for all of India. To make the estimates more precise and reliable, econometricians prefer the use of several time series, for example, one for each district or state, which are together called a panel.

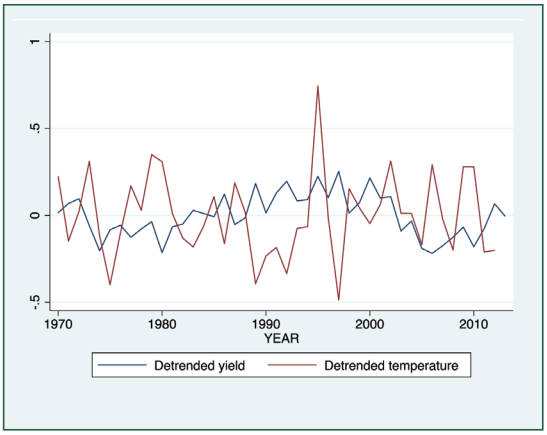

Fig 2: Single time-series (India) of de-trended temperature and wheat yields

The findings are sobering. Auffhammer, Ramanathan, and Vincent (PNAS, 2006), using data on Indian states over four decades found that global warming and aerosol pollution combined had reduced rice production by over 10%. The impact of warming alone was < 5%. Ridhima Gupta and Somanathan (unpublished, 2015) find that wheat yields were about 4.5% lower in 2009 than they would have been if warming since 1981 had not occurred. Reducing aerosol pollution by one standard deviation would increase the wheat yield by 4%, mainly due to an increase in solar radiation reaching the plants.

A number of SANDEE studies reinforce our concern about the agricultural impacts of climate change. In Nepal, Prakash Karn (SANDEE Working Paper 85-14) found that an increase in temperature during the ripening phase raises the yield of rice up to a threshold and then reduces it, with the overall effect being negative. In Tamil Nadu, research by Saravana Kumar (Sandee WP 91-15) suggests that rice and sorghum yields are likely to be 10% lower relative to potential by the end of the century. Haque and Jahan (SANDEE Working Paper 85-13) indicate that rising sea levels and greater storm surge negatively affect rice yield in coastal Bangladesh.

There are distributional effects of these types of climatic changes. For instance, Eshita Gupta, Ramaswami, and Somanathan (unpublished, 2014), using a simple general equilibrium model, find that a decrease in agricultural productivity hurts the landless by three times as much as the resultant fall in GDP. This is due to an increase in the price of food, with the share of food in the household budget as much as 2/3rd for the poorest.

The impacts of climate change are not confined to the agricultural sector. Somanathan *et al.* (ISI Discussion Paper 15-02 2015) using 10 years of data from India's Annual Survey of Industries with over 21,000 manufacturing plants find that output falls by about 3% per degree increase in mean temperature. This effect is driven by high-temperature days. Manufacturing output in India would be 3% higher today if not for warming since 1970.

With warming having already had effects, it is clear that more and worse is to come. Slowing and stopping global warming is, therefore, of great economic importance for South Asia. The governments of the region must also prepare for that part of the warming that cannot be prevented.

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