

South Africa CCDR - CDI inputs

Introduction

Recent research has shown that higher temperatures and water stress are negatively correlated to aggregate output, especially in developing countries with low adaptive capacity (Dell et al., 2012; Burke et al., 2015). Higher temperatures and water stress are associated with reduced agricultural yield as well as lower firm productivity in general (Auffhammer et al., 2006; Deschenes and Greenstone, 2007; Lobell et al., 2011; Traore and Foltz, 2018; Zhang et al., 2018; Somanathan et al., 2021). Higher temperature affects firm productivity through intrinsic labor productivity loss and reduced labor supply (Graff et al., 2014; Somanathan et al., 2021; Park, 2016) and higher production cost due to higher input prices and unreliable energy (Traore and Foltz, 2018). Somanathan et al. (2015) found evidence that heat stress on workers is a vital mechanism, through which temperatures could influence economic output. Using daily firm production data from India, they found that labor productivity declines between 2% - 8% per degree on days above 35°C. Furthermore, they estimate that an additional day of high temperature is associated with a 1% - 2% increase in absenteeism of contracted workers. Climate related disruption may also increase business operational cost through its impact on energy generation. For example, missing or warmer water for power plant cooling needs, due to diminished rainfall or higher temperatures in the catchment area of the waterbody, may result in loss of operating capacity. If the power plant is producing electricity, its output may be restricted through loss of generating capacity, or it may even have to shut down completely when the water level falls below the minimum safe operating level. This may impact the operations of many businesses if there is no alternative power source. Cost of power would ultimately increase as the utility is forced to either buy power from other sources, or power may be rationed, leading to loss of production capacity of dependent businesses.

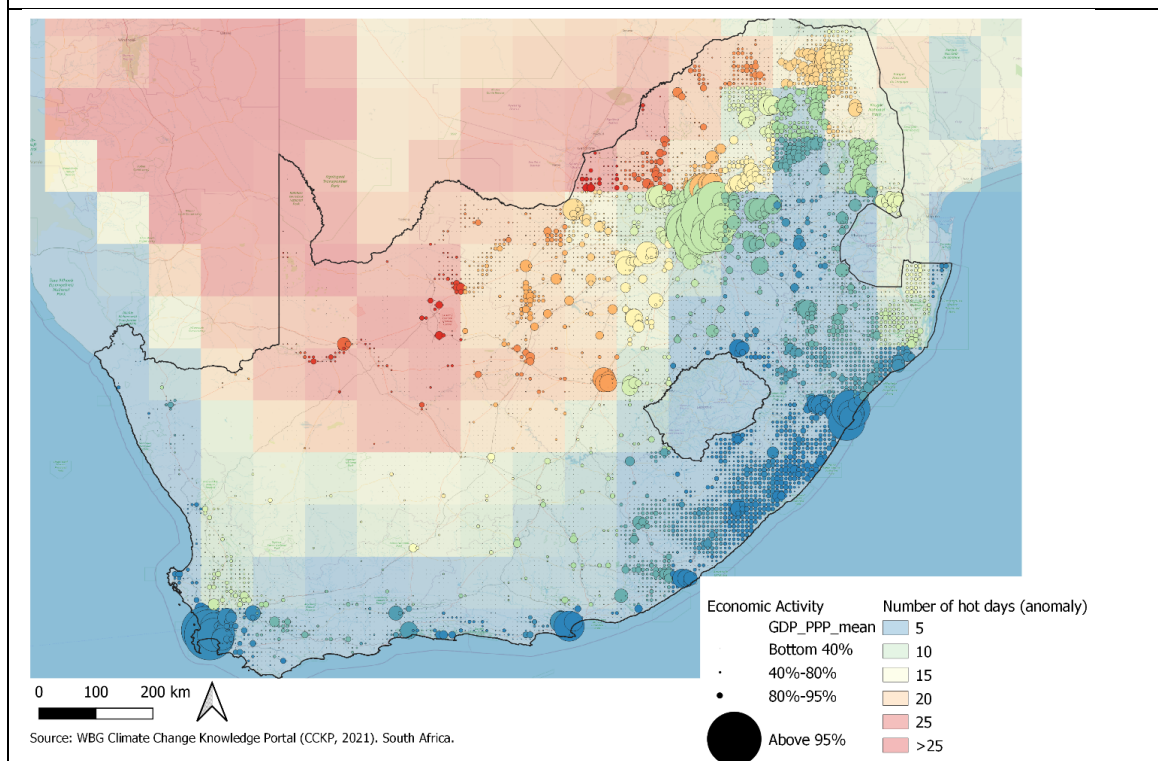
Potential impact of higher temperature on economic activities in South Africa

As Figure 1 illustrates, heat rises are expected to affect economic activities across an important share of the country's landmass. In its perspective, the Intergovernmental Panel on Climate Change observes the trend of increased extreme heat stress in the region is likely to intensify accompanied by increased aridity and droughts. Studies on the impacts of climate on businesses in developing countries have indicated a negative relationship between daily temperatures and measures of firm performance, including revenues, profits, total factor productivity and survival rate (Traore and Foltz, 2018; Zhang et al., 2018; Somanathan et al., 2021). As displayed in table 1, areas representing more than 60% of the country's GDP¹ will experience an increase of 5-20 days in the number of hot days ($T_{max} > 35^{\circ}\text{C}$) in the period 2020-2029 as compared to the period 1995-2014. These heat level rises are expected to be most severe outside the economic centers in Gauteng and along the coast. Overall, 13% of the economy is currently located in areas where the number of hot days in a year is expected to increase by more than 15 days. Firms operating in the manufacturing and services sectors in these areas can be expected to experience substantial productivity losses when the number of days in a year with heat level exceeding 35°C increases. These effects could be substantial in South Africa given the share of the country's landmass that are subject to temperature increase. According to evidence in the literature, these impacts are greatest for labor intensive firms, SMEs, and firms with limited access to technology. Larger firms with

¹ Data source: <https://datadryad.org/stash/dataset/doi:10.5061/dryad.dk1i0>. Note that we are using 2015 GDP (the latest wave from the data source) in this analysis.

better access to capital are often in a position to counteract these impacts through investment in adaptation including spending on air conditioning and their own energy production capacity. These expenditures can be substantial given the large share of GDP's adaptation needs in the country. Due to limited access to adaptation technologies, many SMEs can be expected to struggle to make these investments leading to increased concentration of economic activity in larger firms. The heat rises will also make it more difficult to develop the manufacturing and services sectors in these areas. This is an extra impediment to areas which are already relatively low income. The areas most affected by heat level rises (an increase of over 20 days in the number of hot days) have average incomes that are about 4 times lower than those that are least affected (an increase of 0-5 days in the number of hot days).

Figure 1: Projected Number of Hot Days ($T_{max} > 35^{\circ}\text{C}$) Anomaly for 2020-2039
(Reference Period: 1995-2014)

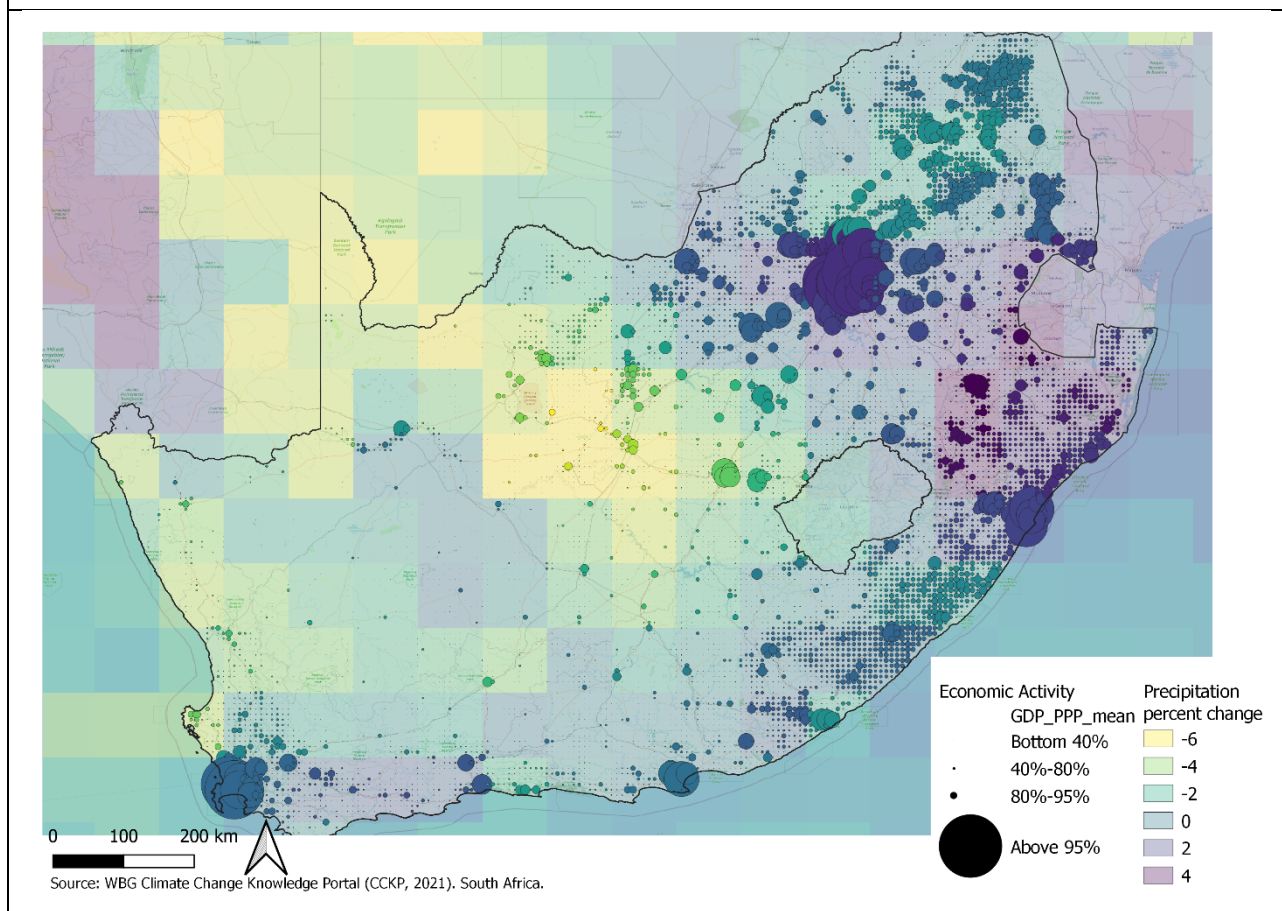


Potential impact of higher water stress on economic activities in South Africa

South Africa remains highly vulnerable to climate risk due to the effects of droughts, floods, storms and a low adaptive capacity. Additional risk stems from South Africa's vulnerability to water and food insecurity, as well as impacts on health, human settlements, infrastructure, and critical ecosystem services (Adaptation Partnership, 2011; CCKP, 2021). These pose challenges to the economy, including via their impact on water and food security, health, and infrastructure (DEA, 2013). Increases in water stress due to lower projected precipitation and higher demand for water will also have direct impacts on agricultural yield as well as firm performance through its impacts on inputs and energy supply. Higher water stress

would affect the country's energy production and supply. As Figure 2 illustrates, water stress is expected to impact firms along the Cape coast with precipitation decreasing by around 2%, as well as firms in the interior of the country such as the North (right above Pretoria) in the province of Limpopo and in the center of the country in Northern Cape and Free State. This has the potential to affect firms' operations through higher water tariffs, the costs of buying water from tankers or water shortages. Firms can adapt to these challenges by increasing expenditure on storage tanks, water recycling, agriculture precision techniques and similar.

Figure 2: Projected Precipitation Percent Change Anomaly for 2020-2039
(Reference Period: 1995-2014)



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Appendix

Table 1: Projected Number of Hot Days Anomaly, GDP, and Population

Number of hot days	Average GDP (PPP) (2011 international \$)	GDP (PPP) shared percentage	Average population density (10km by 10km grid)	Population shared percentage
0-5	60280153.64	36.87%	5289	41.73%
5-10	104487048.63	39.60%	7547	36.89%
10-15	37434358.90	10.58%	2686	9.79%
15-20	35371605.41	9.31%	2394	8.13%

Above 20	12439367.10	3.64%	915	3.45%
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Table 2: Projected Precipitation Percentage Change, GDP, and Population

Percentage change of precipitation	Average GDP (PPP) (2011 international \$)	GDP (PPP) shared percentage	Average population density (10km by 10km grid)	Population shared percentage
Below -2.29%	9995303.90	4.43%	833	4.76%
-2.29% — -0.43%	39653025.04	16.86%	2897	15.89%
-0.43% — 0.58%	46784880.21	23.27%	3417	21.92%
Above 0.58%	119605540.48	55.44%	9603	57.42%