

Evaluating Temperature Trends: Is July 2021 in Chandigarh warmer than Average?

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About the Student:

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Summary:

The planet's climate has gone rogue with intense heat waves in one zone to raging storms in another. The magnitude of the problem has compelled individuals to take immediate action for awareness. This study analyses the temperature trends in July 2021 in Chandigarh, India. It aims to determine if even Chandigarh, one of the greenest cities in India, is challenged by climate change. Our methodology consisted of a statistical evaluation of July temperature data for the past 13 years to test this hypothesis.

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Introduction:

Overwhelming scientific evidence has illustrated that our planet is warming progressively ([IPCC, 2018](#); [Thompson, 2010](#); [NASA, 2021](#); [Cubasch et al. 2013](#); [NCA, 2018](#)). The observed surface temperatures show an escalation of 0.87°C over the decade 2006 to 2015 ([IPCC, 2018](#); [IPCC 2014](#)). According to the World Meteorological Organization, the last decade, i.e. 2011 to 2020 was the warmest decade on record in a recurring climate change trend ([WMO, 2021](#); [Lindsey et al., 2021](#); [Wuebbles et al. 2017](#)), with 2020 and 2016 tying as the hottest years and 2019 bringing up the rear ([NOAA, 2020](#); [Brown, 2021](#); [University of East Anglia and Hadley Centre](#)).

Furthermore, the global average temperature has risen 1.58°C since the late nineteenth century ([Wuebbles et al. 2017](#); [NASA, 2021](#)) owing to the increased anthropogenic emissions of greenhouse gases, primarily Carbon Dioxide ([IPCC, 2018](#); [NASA, 2021](#); [IPCC, 2014](#); [Gaffney et al., 2017](#); [Fahey, 2017](#)). Integrative indicators such as changes in sea level, ocean acidification, hydrological changes corroborate the climate crisis ([IPCC, 2018](#); [Thompson, 2010](#); [NASA, 2021](#); [Cubasch et al. 2013](#); [Wuebbles et al. 2017](#)).

Climate change has led to occurrence of extreme weather fluctuations, including intense changes in the hydrological cycle, with wide ranging impacts from floods to water scarcity ([Cubasch et al. 2013](#); [Tabari 2020](#); [Wehner et al., 2017](#); [Seneviratne et al., 2012](#)). Oceanic uptake of carbon dioxide has resulted in a 0.1 decrease in pH, corresponding to a 26% increase in acidity ([IPCC, 2014](#)). Soaring temperatures have also led to shrinking of glaciers, accelerated loss of sea ice and intensified heat waves, thus increasing the probability of natural disasters namely droughts ([NASA, 2021](#); [Wehner et al., 2017](#); [Smith, 2020](#); [Seneviratne et al., 2012](#)). Beside its effects on the abiotic environment, climate change has had profound impacts on biodiversity causing geological dislocation and regional extinction of several species ([Nunez et al., 2019](#), [Kannan, 2009](#); [Dawson et al., 2011](#)).

According to the Indian Meteorological Department, surface temperature anomalies in India have shown a rise of +0.62°C across the past century, primarily due to post-2000 temperature drift ([Indian Meteorological Department; Srivastava, 2017](#)). India's diverse population and topography makes her more vulnerable to the impacts of climate emergencies ([IPCC, 2014](#); [Mehta et al., 2019](#)). With over 58% of the population dependent on climate sensitive fields, primarily agriculture, weather variations pose severe implications for the economy and the nutritional security of the country ([Guntukula, 2019](#); [Balasubramanian et al., 2012](#)). 68% of the total cultivated land in India rain fed, without proper irrigation equipment, supports 40% of the human population ([Praveen et al., 2020](#)). Changing climate is also one of the biggest contributors to increased natural disasters such as heatwaves, floods and cyclones in the Indian subcontinent ([Praveen et al., 2020](#), [AchutaRao et al., 2019](#)), validation of which can be drawn from the floods in Chennai, and the heat waves of Andhra Pradesh ([AchutaRao et al., 2019](#)).

Establishing the need for climate research, this paper analyses the temperature trend of July 2021 in Chandigarh, India against the mean July temperature of the past 12 years. It discusses the temperature pattern in order to decipher the recent effects of changing climate in Chandigarh by drawing a comparison with the global drift. The article proceeds to illustrate the mitigation of climate emergencies using green architectural design.

Methods:

A) How to determine the temperature measured at 30 ° 43'32.2608"N, 76 ° 46'49.6596"E at 18:00 from July 12 - July 27, 2021 are higher or lower than the average temperature measured from the weather station at 18.00 since 2009?

This research study is based upon data collected across 12 July, 2021 to 27 July 2021 in Chandigarh, India at 30 ° 43'32.2608"N, 76 ° 46'49.6596"E. I gathered the temperature each day at 18:00. The VeiVeeta HTC-2 Plastic Digital Indoor cum Outdoor thermo-hygrometer with the resolution of $\pm 0.1^\circ\text{C}$ was used, with its metal kink held 5 feet above

the ground and 2 metres away from the nearby buildings for 2 minutes to receive a stable measurement. The thermometer kink was placed under an A4 sized cardboard to protect it from direct sunlight.

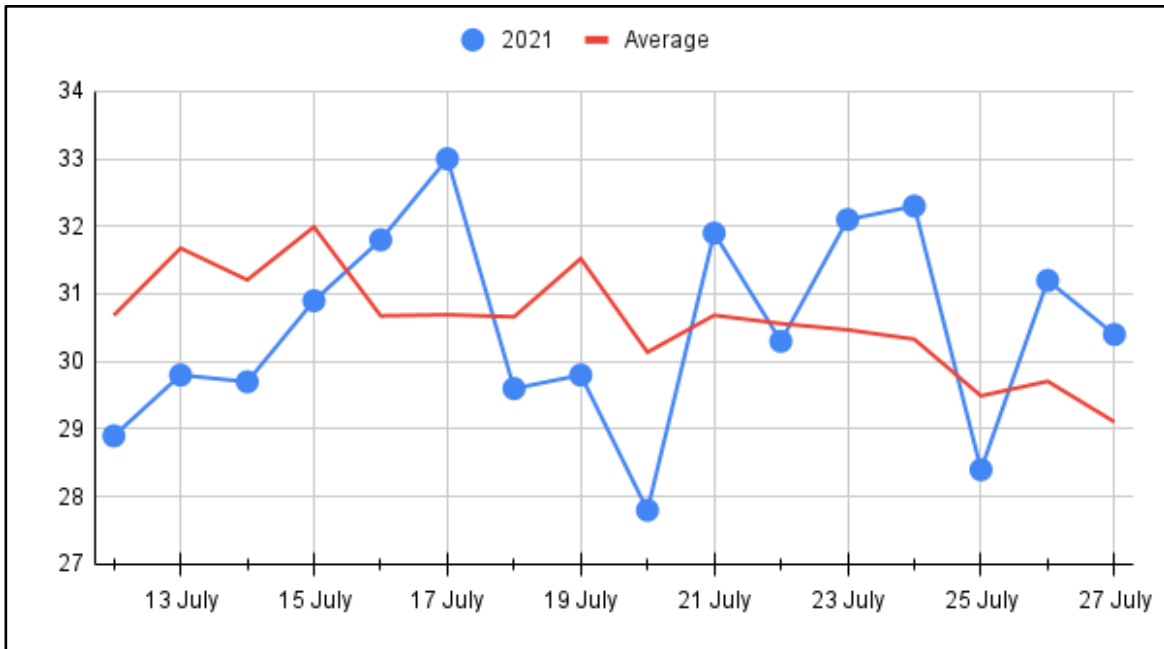
This data of measured temperatures was tabulated and further compared with the daily average temperatures from 12 July to 27 July each year across 2009 to 2020 at 18:00. This information was compiled from the [World Weather Station](#) which computes the temperature from the Chandigarh Airport at 30.6668°N, 76.7863°S. Both data sets were plotted on a graph in order to visually contrast the temperature in 2021 against the average for past 12 years for a particular day within 12th to 27th of July.

B) How to compare the average July temperature of Chandigarh since 2009 with the average monthly temperature of July 2021?

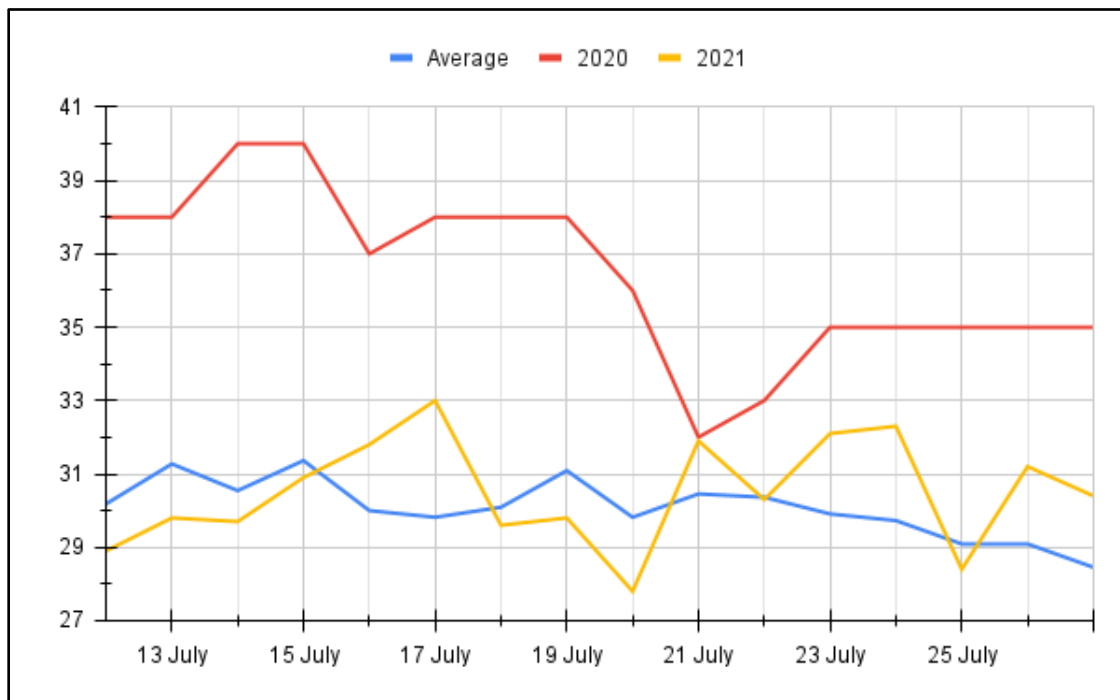
The maximum and minimum temperature for all 31 days of July from 2009 to 2021 was tabulated in a spreadsheet with reference to the World Weather Online Station ([30](#)). Mean temperature for July across all 13 years was calculated and each average was plotted on a graph to represent the temperature trend.

Results:

A) How to determine the temperature measured at 30 ° 43'32.2608"N, 76 ° 46'49.6596"E at 18:00 from July 12 - July 27, 2021 are higher or lower than the average temperature measured from the weather station at 18.00 since 2009?



(Figure 3.1 - Measured Temperature at 18:00 in July (2021) and Average Temperature at 18:00 in July (from 2009 - 2020))

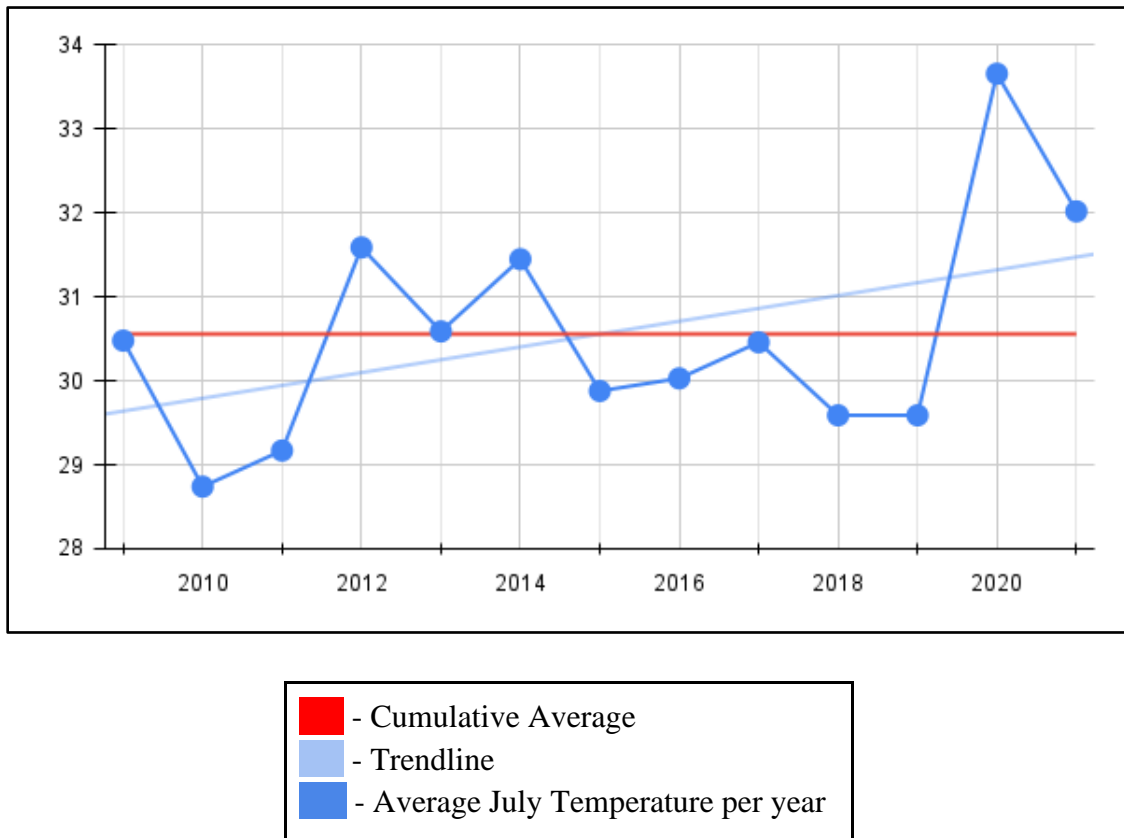


(Figure 3.2 - Measured Temperature at 18:00 in July (2021), Temperature at 18:00 in July (2020) and Average Temperature at 18:00 in July (from 2009 - 2019))

The graphs indicate that the measured temperatures of July 2021 were not significantly different from the past average (see Figure 3.1). An unpaired T-Test showed that the probability of the two datasets to be different was lower than 20%. 2020, on the contrary, presented an average rise

of 6.36°C from the mean temperature (see Figure 3.2). Temperatures across the 2-week span in 2021 display an increasing trend from 12 - 17 July with a sharp drop on the 18th and 25th of July. In general, temperature demonstrates a declining trend with the close of July.

B) How to compare the average July temperature of Chandigarh since 2009 with the average monthly temperature of July 2021?



(Figure 3.3 - Average July Temperature (°C) vs. Year)

As per the data collected from the World Weather Online Station, temperatures in Chandigarh show a slight increase of 6.7% from 2009 to 2021. Temperatures across the past 13 years cumulatively average at 30.56°C. 2012-2014 was a comparatively warmer period whereas all others till 2019 were conversely below average (see Figure 3.3). At a glance, it is clear that 2020 was the warmest year in Chandigarh since 2009 with an anomaly of 3.10°C. Even though the mean temperature in July 2021 has declined by 1.64°C, it remains 1.46°C above the combined average.

Discussions:

The July temperature in Chandigarh exhibits a gradual escalation pattern. This inclined rising fashion could primarily be attributed to anthropogenic emissions. Temperatures are the result of equilibrium of absorbed solar rays and reflected infra-red waves. Greenhouse gases are instrumental in trapping these infra-red waves (>750 nm), raising the temperature ([Jain, 2003](#)). GHGs (Carbon dioxide, Carbon monoxide, Nitrous Oxide) in Chandigarh are on the rise primarily owing to vehicular pollution and increase in private transportation ([Bhargava et al., 2018](#)). This fact coincides with the temperature pattern and can provide a credible explanation for the same.

In the 13 year dataset, 2020 showcases the highest temperature. One plausible explanation for the same could be the significant decrease of fine particulate matter (PM 2.5) during the COVID-19 lockdown ([Zhang et al., 2021](#); [Kumar et al., 2020](#)), which would have resulted in a decrease in the net cloud albedo effect. Cloud albedo effect refers to the enhanced reflection of solar radiations, presenting a cooling impact ([Myhre, 2013](#)). However, substantial reductions in the carbon dioxide levels during the same time period ([Le Quéré et al., 2020](#); [Liu et al., 2020](#)) could contradict the above hypothesis. According to NASA, the cumulative emissions had minimal effect on the avoided warming ([Brown, NASA, 2021](#)).

It is also crucial to note that the analysed data belongs to 2009 - 2021, which includes the warmest decade on record ([WMO, 2021](#); [Lindsey et al., 2021](#); [Wuebbles et al. 2017](#)). There is an increasing probability for these trends to intensify over subsequent years ([Fischer et al., 2021](#)). Thus, the gathered figures support the notions of a warming planet, but are insufficient in proving its occurrence.

Future Research:

It is impossible to predict climate change with a handful of temperature readings. Weather is dynamic and concrete changes can be determined through observations over a prolonged time period, which will eliminate day-to-day weather transitions. This evaluative study can be improved by taking continual temperature data for a longer time span of 1 to 2 decades. Further one can collect data at around 10 - 20 locations in the selected region for a more accurate result.

Solutions:

Buildings account for 19% of GHG emissions across the globe ([Lucon et al., 2014](#); [Altomonte, 2009](#); [Li et al., 2021](#)), thus remain a primary cause of climate change. With the assistance of green architecture, these 'problems' can become solutions. The core of this transition lies in the variables of thermal performances, ventilation, light distribution and visual comfort balanced with the climate and environmental contexts ([Altomonte, 2009](#)). Surprisingly, the fuel to this

transition doesn't lie in modern technology, but in vernacular architecture drawing inspiration from nature (biomimicry) ([Altomonte, 2009](#); [Nguyen et al., 2019](#)).

A recent example can be taken from the Rajkumari Ratnavati Girls' School in Jaisalmer, Rajasthan. Despite being located in the middle of a desert, it uses no artificial air conditioning. Its oval shape with perforated walls of local sandstone, assists efficient airflow, which along with a solar panel canopy on the roof, provide a cooling effect.



Image Courtesy: archdaily.com

Other architectural techniques to optimise energy utilization include the natural ventilation systems of a solar chimney ([Zhang et al., 2021](#)) and using green walls and roofs to expand the functional benefits of plants to provide a cooling effect ([Manso and Gomes, 2014](#)). Green architecture design runs parallel to the imagination, and revives ancient yet sustainable ways to address the issue of climate change.

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