Using time series analysis to identify climate trends and potential impacts to local bird species in Delhi, India

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# Abstract

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# Introduction

As the population in Delhi, India grows each year, so does traffic congestion and industry which are the leading contributors to air pollution, and global warming. Additionally, air quality can have other impacts on local flora and fauna. Pollution is harmful to all living things. For example, research has shown that air pollution can have detrimental effects on livestock which can impact local economies. In this project, we will evaluate climate data from Delhi, India to evaluate patterns in climate change that could pose risks to local bird populations. The conditions we are focusing on are temperature, humidity, wind, and barometric pressure, all of which are used to indicate warming and cooling trends.

# Literature Review

In preparation for the analysis, several peer reviewed sources were explored to investigate what research has been done on the subject and identify any information which may be helpful in our work. As stated previously, this paper focuses on the effects of climate change in Delhi, India and its potential impacts on local bird species. Birds are especially vulnerable to changes in climate and air pollution and it is important to look at how climate change is affecting local species in order to present an overall assessment on the effects global climate change may have on bird populations worldwide. In the paper, “Long-term time series of ornithological data”, Moller and Hochachka explore the diversity of data sources that can be used to study the long-term effects of climate change on birds. The paper discusses the use of local studies, such as this one, to build a robust database of climate and avian data, including nest record schemes, population studies, bird surveys, bird atlases, bird ringing and observation depositories, and museum collections. Unfortunately, coordination on this effort has been inconsistent. According to Moller and Hochachka, “Numerous data allow studies of the effects of climate change on birds. There have been few attempts to coordinate databases” (2019). As more studies are made available perhaps a better understanding of the implications of climate change will become more widespread and mutual interest will facilitate more cooperation between groups.

There have been many research studies conducted about how the change in climate temperature could lead to unforeseen events such as erosion and accretion in land dynamics as well as the alteration in species diversity and productivity. One past study, “Climate change impacts on Indian Sunderbans: a time series analysis” discusses how climate change is affected surrounding lands. The increase of downstream salinity due obstruction in upstream has led to decrease in transparency of water causing decrease in phytoplankton and fish, density and diversity in the central sector of Indian Sunderbans. Based on this study, we could easily come to the conclusion that not only does temperature effect the environment and non-living things but also living organisms such as plankton, fish, and birds.

In addition to literature focused solely on environmental factors, it is important to look at past research and methodologies used to quantify climate change in general. In the paper “Generating a Set of Temperature Time Series Representative of Recent Past and Near Future Climate”, the author discusses a methodology for building a large sample of temperature specific indicators based on the decomposition of the time series into deterministic parts, such as seasonality and trends. While this study focused on the interrelation between climate and energy systems, the methodology for identifying trends in temperature was of specific interest and this information could also be useful in other areas or study as they relate to climate change.

# Main Body

Our approach is to use time series techniques to examine the data looking for patterns and trends which might indicate the region is becoming warmer or cooler. If an overall trend is established recommendations can be made towards mitigating the risks associated with the trend. For example, if the climate is trending towards becoming cooler and wetter, than levees may need to be incorporated into low lying flood plain areas where sensitive bird species may nest. If conditions indicate a warming or drying trend than this poses a much more serious problem as little can be done to mitigate the effects of a drying climate. In this case, more emphasis should perhaps be put on climate regulations to decrease greenhouse gasses in the hopes that the trend can be reversed before irreversible damage is done to local bird populations.

The data indicates that every year mean temperature increases approximately 0.36° celsius indicating an overall upward trend. The intent of this project is to analyze local weather data to identify patterns and trends and explore whether they are significant enough to cause harm to bird species living in the surrounding areas. This can help environmental agencies and government authorities take action to mitigate the effects if the trend is in fact threatening. After a brief preliminary analysis, it was found that there is a sinusoidal seasonality with a period of 12 months. The temperature is at its lowest in December, which coincides with winter and peaks around July, which coincides with summer. The temperature is not stationary since the trend is slightly upward, indicating an increasing average temperature year after year. It can be observed that some of the features, such as humidity and pressure, are correlated. Identifying correlated features can help eliminate redundant information in order to simplify the model. The dataset contains weather information from 1st January 2013 to 24th April 2017 which is long enough to identify cyclical patterns in temperature over a 12 months period.

# Conclusion

Construction of the model described above can help agencies estimate future temperatures, which can give insights into the extent of climate change and whether it will be severe enough to be threatening to the bird species living in the surrounding areas.

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