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ANALYSIS OF PARTICULATE MATTER PM2.5 & PM10 OVER DIFFERENT REGIONS OF NEPAL

Shreedip Kaini*, Dr. Binod Adhikari*

**Department of Physics, St. Xavier's College, Maitighar, Kathmandu, Nepal*

Correspondence: Shreedip Kaini, kainisridip5@gmail.com

A. Introduction

Particulate matter (PM) pollution poses a global environmental and public health challenge, prompting an in-depth exploration of PM2.5 and PM10 levels across diverse Nepalese regions. Investigating how these levels fluctuate across different regions and human interventions is crucial for a thorough analysis. Employing spectral analysis, including Continuous Wavelet Transform (CWT), we inspected the temporal and geographical dynamics of PM2.5 and PM10 throughout a year.

B. Dataset & Locations

Table 1: Location of stations along with topological distribution and population density.

Site	Longitude	Latitude	Topographical Region	Population Density (People per sq. km.)
Chitwan	84.37	27.64	Terai	853
Kathmandu	85.32	27.71	Hilly	17440
Dhankuta	87.33	26.98	Hilly	324
Simara	84.97	27.16	Terai	408
Rara	82.05	29.55	Himalayan	51
Hetauda	85.033	27.42	Hilly	740

The PM concentration data for the study was taken from the Air Quality Index (AQI) which, for Nepal, sourced its data from the Government of Nepal, Ministry of Population and Environment, Department of Environment Air Quality Monitoring.

C. Methodology

In this study, the Continuous Wavelet Transform (CWT) technique is applied to PM2.5 and PM10 pollution data after linear and cubic spline interpolation to identify dominant frequencies and periodic components over time. Using the Morlet wavelet function, CWT provides valuable insights into the variations and patterns within the particulate matter data.

D. Results

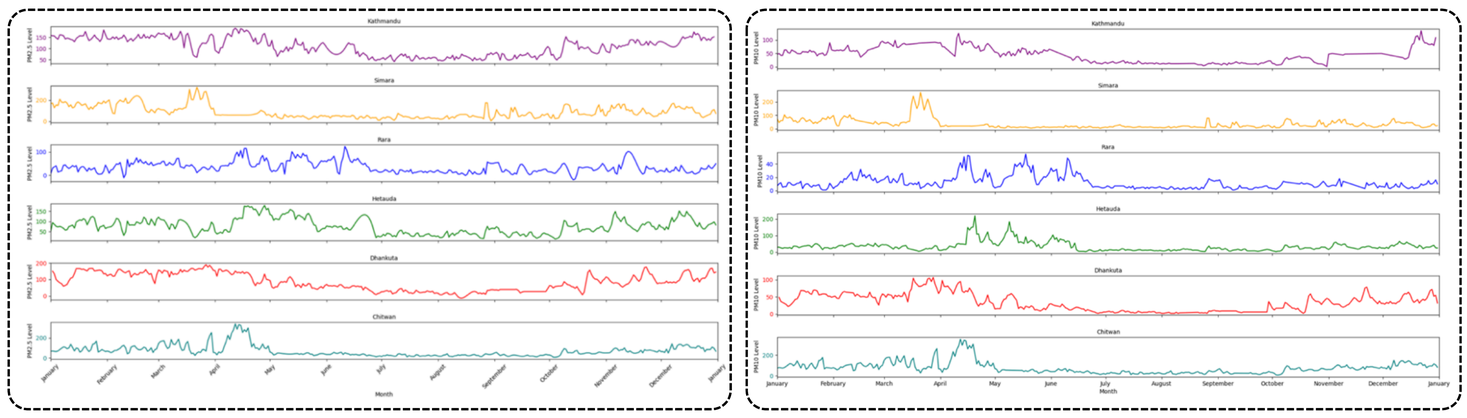

Figure 1 and 2 (Left to right): Variation of PM2.5(left) and PM10(right) over 12 months of 2023 at different stations of Nepal. Each subplots shows the pollutants concentration level vs months' graph for unique stations.

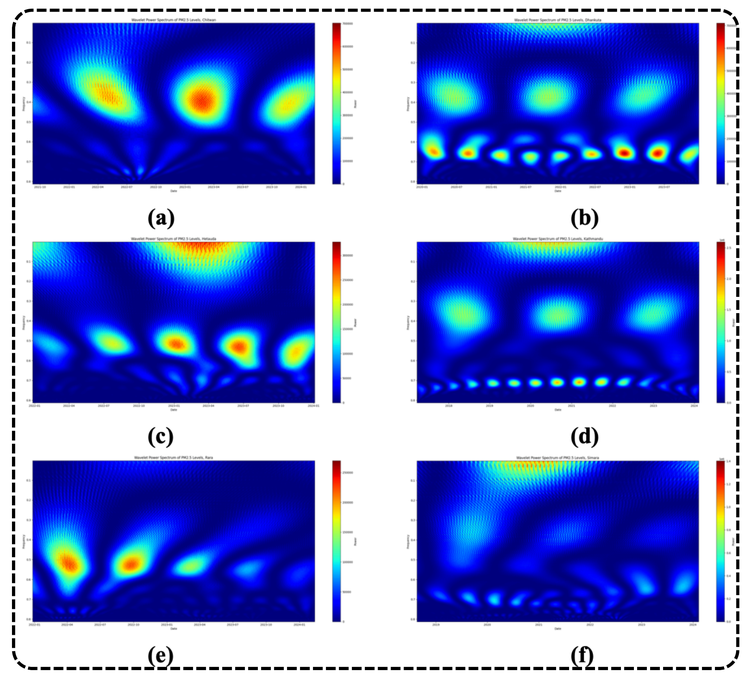

Figure 3: Power Spectrum Analysis through CWT of PM2.5 level over different duration between six different stations of Nepal.

Figures 1 and 2 illustrate the temporal variation of PM2.5 and PM10 concentrations respectively over six different regions of Nepal. Irrespective of its value, the rise and fall trend of PM2.5 and PM10 concentrations is similar in all stations indicating that PM2.5 and PM10 levels fluctuates in accordance to the seasonal variation.

Figures 3 and 4 illustrate the frequency vs. time relationship of PM2.5 and PM10 respecticely across different years for Chitwan, Dhankuta, Hetauda, Kathmandu, Rara, and Simara. The Y-axis represents frequency, the X-axis represents time, and the color spectrum indicates intensity. While different years show varying frequencies and intensities, some stations exhibit similar trends.

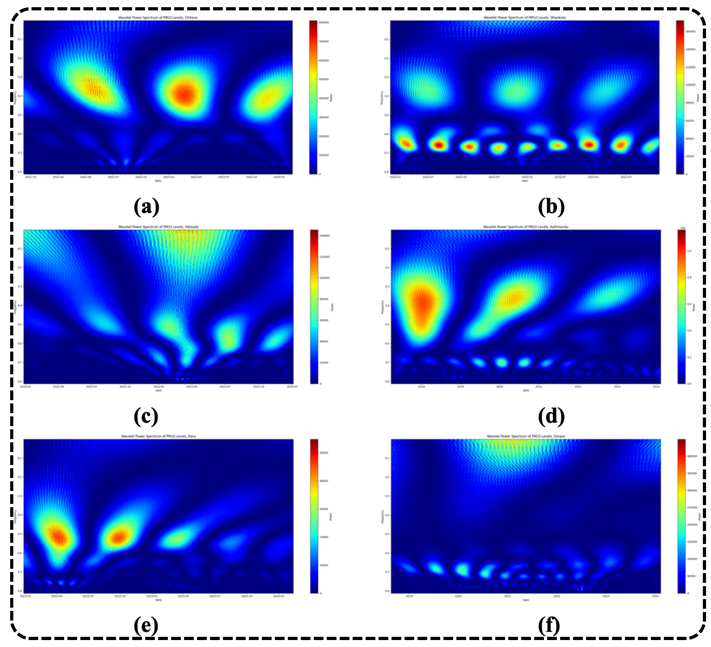

Figure 4: Power Spectrum Analysis through CWT of PM10 level over different duration between six different stations of Nepal.

E. Findings

- The fluctuation of PM in Himalayan region with low human intervention is quite low and maximum pollution level is also comparatively low.
- In Hilly region, the PM level was high in places with both high and low population density in relative scale.
- In Terai region, the PM level was found higher than the station at Hilly region with comparable population density.
- The stability observed in low-frequency coefficients suggests persistent trends, while the identified cycles contribute to understanding of the seasonal variability in PM2.5 and PM10. The PM concentration is higher during Winter and Spring which might be due to the influence of various meteorological parameters.

F. Conclusion

This study examines the analysis of PM2.5 and PM10 across Nepal's diverse regions over a year, focusing on temporal and geographical dynamics. It advocates for more monitoring stations and advanced methods to improve air quality understanding, suggesting that continuous data and meteorological information could offer deeper insights into geographical and atmospheric influences on particulate matter levels.

Contact: kainisridip5@gmail.com, 020bscphy018@sxc.edu.np

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