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Air Quality Health Index and Discomfort conditions in a heat-wave episode during July 2024 in Rhodes Island

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INTRODUCTION & AIM

Climate conditions in combination with the concentration of pollutants increase the human health stress and exacerbate systemic diseases. City of Rhodes is a desirable tourist destination that is located in a sensitive climate region of southeastern Aegean Sea in Mediterranean.

In this work, hourly recordings from a mobile air quality monitoring system which is located in an urban area of Rhodes city, are employed in order to measure the concentration of pollutants (SO_2, NO_2, O_3, PM_{10} and $PM_{2.5}$) and meteorological factors (pressure, temperature and relative humidity). Furthermore, Air Quality Health Index (AQHI) and Discomfort Index (DI) are calculated to study the impact of air quality and meteorological conditions on human health.

The analysis is conducted during a hot summer period, from 29 June to 14 July 2024. During the second half of studied period a heatwave episode occurred affecting the bioclimatic conditions over the city.

Results show that despite the fact that the concentration of pollutants is lower than the pollutants thresholds (Directive 2008/50/EC), the AQHI and DI conditions degrade significantly over the heatwave days. The AQHI and DI simultaneously are increased during the days of heat episode showing a possibly negative synergy for the health risk. Both the day maximum and night minimum temperature are increased (about 0.8 and 0.6 °C, respectively) during the heatwave days as compared to the whole studied period.

This work is employed in the context of "ELEKTRON" project which aims to study the impact of traffic emissions on air quality over the southeastern Aegean Islandic regional-based ecosystems.

METHOD

Figure 1. *The location of mobile air quality monitoring system, placed on an urban environment of Rhodes city.*

Hourly recordings of:
- SO_2, NO_2, O_3, PM_{10} and $PM_{2.5}$ and
- meteorological factors:
  - temperature (T),
  - relative humidity (HR) and
  - Air pressure (pr.)

Measurements:
- During the period from 29th June to 14th July, 2024.
- A Calibrated AQ-Mesh mobile air quality monitoring system is employed.
- The system is located about 3m above the road in the urban area of Rhodes city (Agios Nikolaos region, Canada Street (**Fig. 1**)

The **bioclimatic conditions** and **the impact of air pollution on human health** were studied using:
- discomfort index (DI; Equation 1) and
- air quality health index (AQHI; Equation 2)

$$DI = T_h - 0.55 * (1 - 0.01 * RH) * (T_h - 14.5) \quad (1)$$

$$AQHI = \frac{10}{10.4} * \left(100 * (e^{0.000871 * NO_2} - 1 + e^{0.000537 * O_3} - 1 + e^{0.000487 * PM_{2.5}} - 1)\right) \quad (2)$$

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RESULTS & DISCUSSION

- $PM_{2.5}/PM_{10}$ Ratio ranges from 0.4 to 0.7 (**Fig. 2**).
- AQHI and DI are increased during the second half of the studied period (**Fig. 2**).
- During the warm period (7/7 -14/7) the DI are increased and the concentration of pollutants lead to degraded conditions (increased DI and AQHI values) as compared to the period 29/6 - 6/7, 2024 (**Fig. 3**).
- The hours that DI are increased (~1-1.5) are the midday hours (Fig. 4a) and the AQHI are degraded (about 0.75 to 1.25) during evening hours (**Fig. 3**).
- The correlation (~0.5) between DI and AQHI shows that these conditions could have a combined negative effect on population (**Fig. 3**).
- The higher AQI and DI values are presented during the day hours indicating increased health risk (**Fig. 4**)

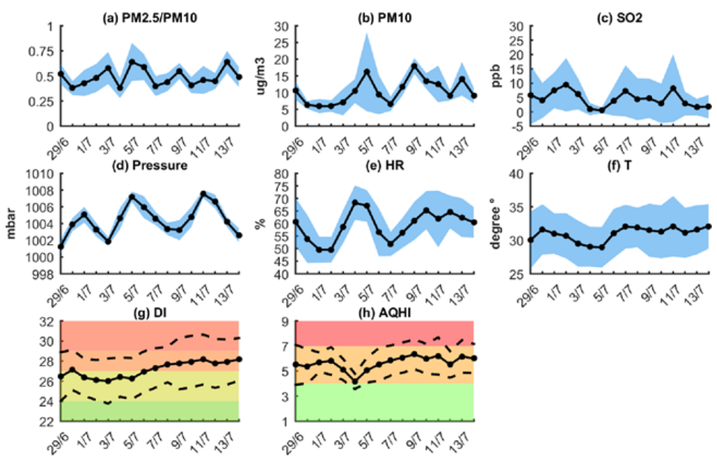

Figure 2. *Daily mean of (a-c) $PM_{2.5}/PM_{10}$ ratio and concentration of pollutants, (d-f) meteorological factors, (g) DI and (h) AQHI. Shaded light blue area indicates the mean value plus/minus one standard deviation. The cold/warm color shaded areas in subplots (g) and (h) denotes improved/degraded conditions for population.*

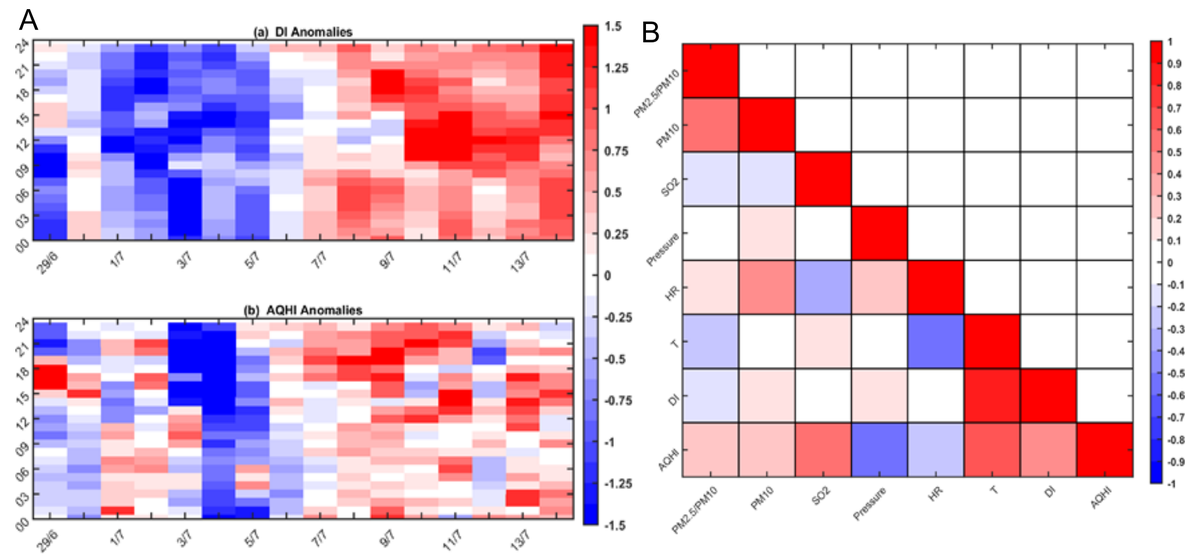

Figure 3. *(A) (a) The hourly DI anomalies with reference to the whole period diurnal mean DI cycle and (b) the hourly AQHI anomalies with reference to the whole period diurnal mean AQHI cycle. (B) Pearson correlation among $PM_{2.5}/PM_{10}$ Ratio, concentration of pollutants and meteorological factors.*

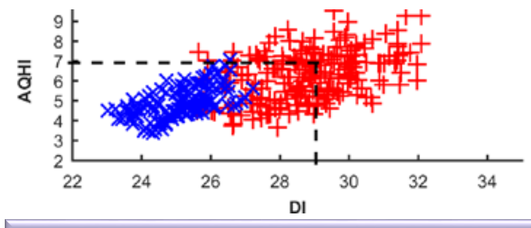

Figure 4. *Scatter plot of hourly DI and AQHI. The red/blue points indicate the day and night hours DI and AQHI*

CONCLUSION

- AQHI and DI values show that the people's health is negatively affected during the days that the heatwave event occurs (studied period: from 7th July to 14th July 2024).
- AQHI and DI during the night hours show improved conditions for the human health as compared to daytime hours.
- The synergy between the increased concentration of pollutants and the extreme meteorological conditions, mainly during the daytime hours, increase humans' health risk in the urban environment of Rhodes city.

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