Migratory analysis of PM10 and O3 pollutants between urban and rural areas using functional data: EVIDENCE from Catalonia

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Abstract

This paper analyzes the relationship between rural, urban, and suburban areas relative to PM10 and O3 pollution levels within the Spanish Autonomous Community of Catalonia (CC), characterized by a complex orography, and unequal population and industrial distribution. To diagnose significant correlations between these areas, this article uses functional data in conjunction with functional Kendall's tau statistic, which acknowledges the continuous nature of the variables and avoids several

simplifying hypotheses that are imposed by other quantitative methods. These features are valuable in a context where the variable of interest, pollution, exhibits a large degree of dispersion over time and seasons. Data have been collected from 44 air monitoring stations on an hourly basis within the CC between the years 2013 and 2020. According to the results, remote urban and rural places often displayed a high correlation for both O_3 and PM_{10}, while some adjacent areas featured low

correlations. This phenomenon should be attributed to complex recirculation patterns within the CC, where the regions of Reus, Amposta, and Constantí (located in Tarragona province) and the Vic and Berga Plains (an area of intense economic activity in the north of the Barcelona Metropolitan Area) exert strong infuences on air pollution at rural sites. Regional wind fows and Saharan dust episodes may exacerbate these efects. The fndings ofer implications for environmental policy:

policymakers should focus on the entire CC when mitigating pollution, not just Barcelona and Tarragona cities as rural sites are damaged by polluted air masses generated in urban regions.