



Partitioning the Effects of Weather and Air Pollution on Human Mortality in Santiago, Chile

INTRODUCTION

One of the greatest challenges in modern epidemiology has been quantifying the impact on human health of prolonged exposure to air pollution. Meanwhile, because of the growing concern over the health consequences of climate change, numerous studies have examined the impact of extreme weather conditions on health. Yet most studies only speculate as to the combined impacts of both weather and air pollution. These impacts are often claimed to be “synergistic” or “interactive”, but few studies have measured whether the combined effects are antagonistic, additive, or non-linear.

STUDY AIM

- 1.) Identify regional weather patterns associated with poor air quality and elevated cause-specific mortality
- 2.) Quantify the independent and combined impacts of weather and pollution on human mortality rates.

Coastal Range 1200-1400 m
 Chacabuco Hills 1200 m
 Andes Range 3000 m
 Front 3000 m

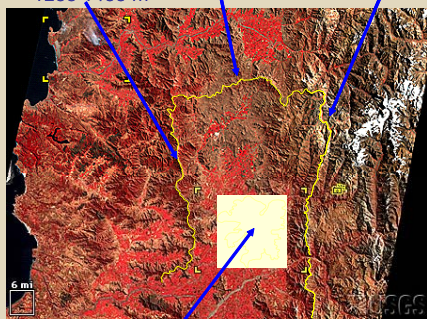


Figure 1. Santiago, Chile: Regional topography forms a closed basin, trapping air pollution

Acknowledgements

The author thanks Mark Cane, Karen Tomic, Alexey Kaplan, Luis Cifuentes, Ignacio Olaeta, Patricio Acetuno, Tracey Holloway, José Rutllant, and Alla Fil for their help with this study.

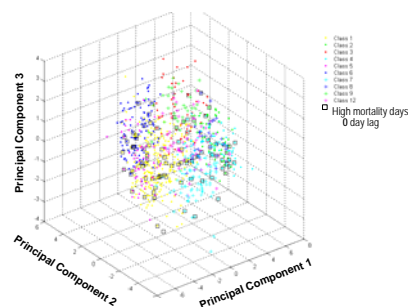


Figure 2. Results of the cluster analysis for weather classes. High-mortality classes were determined based on a the density of high-mortality days.

RESULTS

NO₂ levels were significantly associated with total and respiratory mortality, though the relationship was weaker than that of temperature or dew point with mortality. The effect of extreme weather was strongest at short lag times (zero to three days), while the effect of pollution was strongest at longer lag times (three to six days).

High Mortality Weather and Pollution Classes: Surface pressure and winds

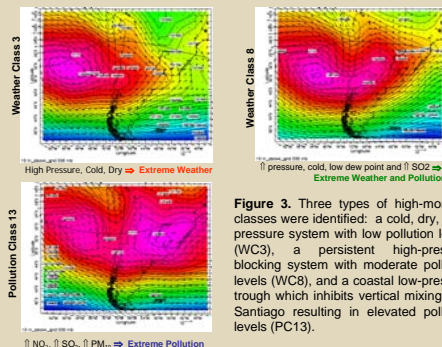


Figure 3. Three types of high-mortality classes were identified: a cold, dry, high-pressure system with low pollution levels (WC3), a persistent high-pressure blocking system with moderate pollution levels (WC8), and a coastal low-pressure trough which inhibits vertical mixing over Santiago resulting in elevated pollution levels (PC13).

METHODS

Each day in the study period was assigned to both a weather class and a pollution class using a synoptic temporal classification scheme (Figure 2). Stressful pollution and weather conditions were characterized using descriptive statistics. Forward stepwise multiple regression was used to determine the relative importance of weather and pollution variables in explaining the variation in excess deaths.

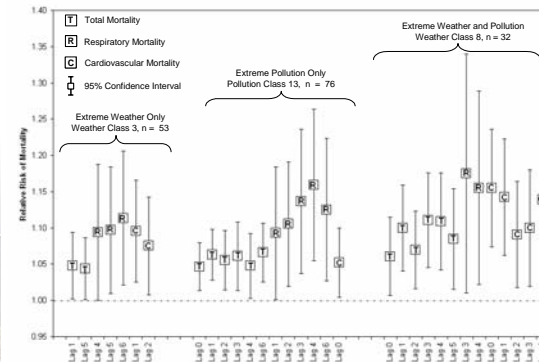


Figure 4. Differential impacts of pollution and weather on mortality: Cardiovascular deaths were more sensitive to extreme weather conditions, while respiratory deaths were more sensitive to high pollution levels.

CONCLUSIONS and BROADER IMPACTS

Pollution levels and weather conditions were both significantly associated with the number of excess deaths. The effect of simultaneous extreme weather and elevated levels of pollution on total mortality was approximately equal to their independent effects, indicating that their combined impact is additive, rather than antagonistic or synergistic. Applications of this methodology include improving pollution warnings and weather watch systems and helping to define research priorities with respect the human health impacts of global climate change.

