White Paper:
CO_2, Climate Change and Public Health in the Urban Environment

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Rising levels of carbon dioxide (CO_2), in addition to trapping more heat, promote plant pollen production and fungi, and alter species composition by favoring opportunistic weeds (like ragweed and poison ivy). Other emissions from burning fossil fuels in cars, trucks and buses form photochemical smog that causes and exacerbates asthma, while diesel particulates help deliver pollen and molds deep into lung sacs. The combination of air pollutants, increased aeroallergens, and the prolonged heatwaves increasingly associated with a changing climate, may be contributing to the increase in respiratory problems, particularly for growing children. These impacts disproportionately affect poor and minority groups in the inner cities.

Allergic diseases are the sixth leading cause of chronic illness in the U.S., affecting roughly 17% of the population, and costing the health care system about $18 billion annually. Approximately 40 million Americans suffer from allergic rhinitis (hay fever), largely in response to common aeroallergens, resulting in 3.8 million lost days of work and school. Asthma is a more complex and serious disease characterized by lung inflammation resulting in shortness of breath, or wheezing. It commonly begins in childhood, and frequently requires doctor visits, medications, emergency visits, hospitalizations, school absences for the children and lost work time for the parents.

Currently, the CDC estimates that the prevalence of asthma in the U.S. adult population is approximately 7.5% of the U.S. population (16 million people). The self-reported prevalence of asthma increased 75% from 1980-1994 in both adults and children. However the largest increase of 160% occurred for preschool aged children and overall rates are now 2-3 times what they were in the early 1980s. Low income families, African Americans and Hispanic populations are disproportionately affected above the overall average, with high levels of prevalence, illness and mortality.

Although allergic diseases have a genetic component, such a rapid increase in disease occurrence over two decades is likely the result of changes in environmental exposures. Several studies have elucidated the potential impacts of rising CO_2 levels and global warming on plants. In general, as a result of increasing temperatures and CO_2, plants respond with enhanced photosynthesis, biomass and reproductive effort. These first two are positive responses for agriculture; but the unexpected side affects of disproportionate increases in pollen production of opportunistic weeds has implications for the composition of plant communities and for allergic individuals.

Climate warming has also affected the timing of plant flowering. The "phonological" changes in plants include an advance in budburst in spring, thus advancing the allergenic pollen season. The rate of these advances (close to one day per year)) provide some of the best evidence of the current impacts of recent climate change.

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Recent studies have shown increased pollen production under conditions of elevated CO_2. Ragweed (*Ambrosia artemisiifolia)* is a weed that grows best in disturbed areas and produces potent pollen that contain allergens. In controlled environment experiments, plants grown at 2 times ambient CO_2 had a slightly greater biomass (10% taller), but produced 40 to 61% more pollen than those grown at current levels.

Evidence for climate change effects on fungal growth and reproduction is less well documented, although the implications for allergic disease are just as important. As it is for pollen, exposure to fungal spores (mold) is unequivocally associated with exacerbations of allergy and asthma. Long-term field experiments with elevated CO_2 show that some fungi – those in arbuscular micorrhizal associations with trees -- have enhanced growth and sporulation. While more evidence is needed to establish the certainty of these effects for a wider range of fungi, plausible arguments can be made for the likelihood of increased fungal biomass which would be needed to degrade the increased plant biomass projected under climate change scenarios.

Urban environments, in particular, are sensitive to these pollen increases. Ragweed grows best in open disturbed fields, abandoned lots and old railway lines. The higher temperatures in inner cities (often 7 degrees F above surrounding rural areas) and the increased levels of CO2 trapped in unhealthy urban air masses mean greater pollen production from urban lots with ragweed. As diesel particles help deliver pollen (and molds) to sensitive immune cells in the lungs, idling and moving trucks and buses mean even greater exposure for those living in inner cities. Finally, high ozone levels in summer – especially severe during heatwaves – deliver more pollutants to urban dwellers.

References and full report "Inside the Greenhouse: The Impacts of CO_2 and Climate Change on Public Health in the Inner City" is available on website: http://www.med.harvard.edu/chge/policy/policy.html

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