Fossil fuels, allergies, and a host of other ills

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Our defenses are under assault from a growing spectrum of challenges. For allergies and asthma, most research has focused on indoor pollutants, genetic predispositions, and socio/emotional factors. During the past decade, however, there has been an explosion of new work regarding outdoor sources of respiratory irritation and sensitization, and all these emerging issues are associated with the combustion of fossil fuels.

In the past 3 decades, asthma rates have risen several fold throughout the developed and developing world. There are multiple drivers and some are additive; others are acting synergistically.

Rising ragweed pollen is the leading edge. Repeated studies[1-3] confirm that elevated CO_2 stimulates weeds to produce pollen disproportionately to the photosynthetically derived growth in their biomass. It seems weedy, opportunistic species that thrive better in disturbances profit most from CO_2, putting the excess carbon into their male, reproductive, territorially seeking parts. Poison ivy (*Toxicodendron* taxa) does extraordinarily well, growing in vine abundance and toxicity, the chemical within it, urushiol, becoming stronger,[4] just as the pollen grains in ragweed become more allergenic (as demonstrated by electrophoresis).[5]

Inside inner cities, a "CO_2 dome" forms,[6] trapping ambient CO_2 levels in the 400s, 500s, and 600s of parts per million by volume. (The global average is now 387 ppm; preindustrially it was 280 ppm.) High levels of CO_2 inside the dome-shaped urban heat island effect affect inner-city ragweed (and fast-growing trees in spring) and most likely contribute to the heat-trapping in the urban setting, whereby temperatures can range 10°F above those in the surrounding countryside. Ground-level ozone from nitrogen oxides, another by-product of burning fossil fuels, combined with volatile organic compounds, is another heat-trapping (and lung tissue–damaging) agent. Increased ground-level ozone or photochemical smog exacerbates asthma and most likely initiates new cases,[7] and ozone formation is increased during heat waves (which are increasing with climate change from burning fossil fuels).

Trees are also feeling the effect of rising CO_2.[8] The Duke University Free-Air CO_2 Enrichment (FACE) experiments in North Carolina found that loblolly pines grown under elevated CO_2 grow a bit more but produce 3 times the number of cones and seeds.[9] Fast-growing pioneering trees—the opportunist trees—that like forest edges and pop up after disturbances (like fires, cuttings, blights, and blow-downs) appear to do especially well. Since the 1970s, the date of spring flowering has advanced 30 days,[10] the seasons changing with a changing climate from burning fossil fuels.

Extraordinary spring pollen counts have been recorded in recent years (long-term records, save for in the paleo [ice] record, are sparse), and the early arrival of spring is extending the spring allergy and asthma seasons. (Allergies are also being reported anecdotally in the not-so-dead of winter; flowers sprout during especially warm Januaries.) In seasons with increased warmth and moisture, as during the 2008 spring, the addition of CO_2 and nitrogen provide a plethora of stimuli, making for hyperproductive tree pollen production. (Coastal marine systems are also feeling the effects of overfertilization, with nitrogen from multiple sources—sewage, agriculture, and aerosolized nitrogen from coal-fired plants.)

Some arbuscular mycorrhiza, fungi that hug the roots of trees, nourishing and supporting their growth (which pop up as mushrooms, their fruiting bodies), are also getting a boost from more CO_2 and are making a lot more spores.[11]

And now to a "nasty synergy."[12] Diesel particles, known respiratory irritants, turn out to be excellent delivery systems for aeroallergens (pollen and spores). Pollen grains and spores attach to diesel particles, as shown by scattering electron microscopy,[13] and are carried deep inside the lungs to the twigs and leaves of the pulmonary tract. The diesel particles (from burning fossil fuels) also contain nitrates that irritate mast cells, boosting the allergenic assault.

Before leaving the particulates (from burning fossil fuels and forests), black soot has just been found to play a stronger role in global warming than previously appreciated.[14] Black soot traps outgoing long-wave radiation—as do CO_2, CH_4, ozone, chlorofluorocarbons, and H_2O—and, as it settles in ice and snow, decreases the reflectivity (albedo) of otherwise reflecting surfaces (ie, holding heat). Its influence is now calculated to be 0.9 W/m^2, whereas that of CO_2 is 1.66 W/m^2. The good news is that the black carbon can wash out in weeks, whereas CO_2 lasts for a hundred years. Cleaning the composition of fuels we use means removing sulfates (which cool by reflecting sunlight and seeding clouds) and the black soot that enhances warming.

CO_2 itself has other consequences. Oceanic absorption is leading to ocean acidification, threatening coral reefs and other calcareous marine life by altering the saturation states of calcite and aragonite ($CaCO_3$).

Agricultural weeds are also getting a boost. Today, weeds, pests, and pathogens destroy an estimated 42% of growing and stored crops (equaling ~$300 billion losses) annually.[15] While rising CO_2 favors growth of weeds (requiring more herbicides), the higher C:N ratio in the leaves means that insect pests must

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eat more leaf mass to gain the nitrogen they need to grow[16] (increasing pesticide use). Herbicides, fungicides and pesticides—all derived from petrochemicals—are persistent organic compounds that further challenge the immune (and reproductive) systems.

There is yet another problem stemming from a solution to the climate crisis. Burning ethanol from crops produces CO_2 equal to that it takes up (this is no surprise) but also emits acetaldehyde and formaldehyde, volatile organic compounds that help form smog. Burning ethanol/gasoline mixtures also produces aromatics (eg, polycyclic aromatic hydrocarbons), and burning biodiesel produces more NO_xs and particulates than burning gasoline.

Indeed, we can only reduce all these hazards by minimizing the liquid fuel we use. Thus the panoply of healthy solutions includes walking and biking, smart (mixed-use) urban growth, vastly expanded public transport, and hybrid electric vehicles (cars, buses, trains, and ships) plugged into a smart, cleanly powered grid.[17]

Aside from the health consequences of climate change and the potential for catastrophic impacts on Earth's life-support systems,[18-20] the rise in atmospheric levels of carbon dioxide from burning fossil fuels and felling forests is affecting plants in ways few projected just a decade ago. The cumulative impacts of the increased aeroallergens, particulates, ground-level ozone, and the early arrival of spring and persistence of fall are altering air quality and respiratory health. The most aggressive scenarios portend much higher CO_2 levels that exist today, while some leading scientists struck by climate instability and the impacts of CO_2 on ocean pH are calling for a return to 350 ppm.

For social, ecologic, and health reasons, we must wean ourselves from fossil fuels. Beyond combustion lies their exploration and extraction, mining, and refining—all hazardous to our health and the environment. The quest for oil spoils coasts and drives nations into wars, while the mountain top removal silts streams and valleys, spawning cancer clusters. Combustion causes air pollution, acid rain, and climate change.

There are major choices to be made along the path away from fossil fuels. The public health, healing, and health research professions have a key role to play. By examining the life cycle costs of the fuels we use and of proposed technologies and practices, we can help policymakers and industrial leaders make well informed decisions. With the right set of financial incentives and policy instruments, we may just be able to help steer society onto a path leading to a healthy and sustainable energy future.

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