Fine particle pollution: a beadcrumb trail through the SDG maze

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Background

Combustion produces the energy essential to human activity, but emits a range of pollutants, including CO_2 and fine particles. While CO_2 primarily impacts the climate system, the fine particles produced by combustion affect climate, health, ecosystems and society. These emissions, which have increased rapidly since the start of the industrial revolution, are now reaching levels that threaten the proper functioning of all the complex systems on which the sustainability of our societies depends. As these particles reach and affect all ecospheres (i.e. atmo-, cryo-, hydro-, pedo-, bio- and anthroposphere) during their life cycle, reducing their emissions contributes to many of the Sustainable Development Goals (SDGs).

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Further reading
https://www.ird.fr/black-carbon-la-face-sombre-de-lactivite-humaine

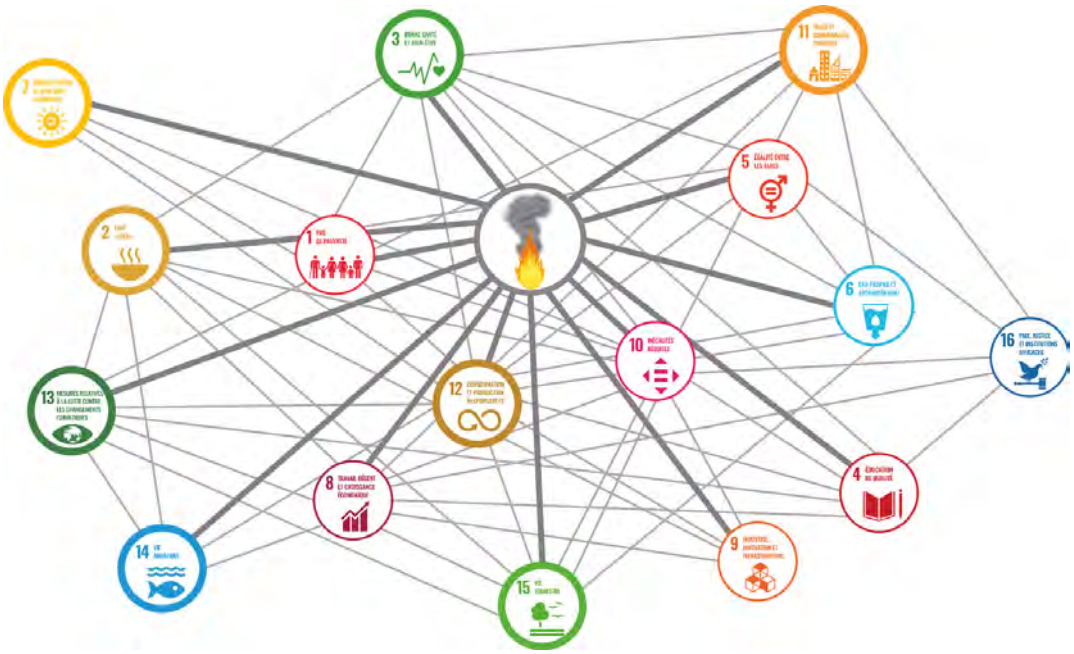
An age-old form of pollution that has evolved with society

Until the middle of the 19th century, energy was produced by burning biofuels (wood and charcoal). After that, the widespread use of fossil fuels led to a proportional increase not only in CO_2 and fine particle emissions from combustion, but also in population size, urbanisation, GDP per capita, literacy rates and life expectancy. So while the discovery of fire was the first milestone in the development of societies, the burning of fossil fuels has made us more numerous and, on the whole, more urban, richer, older and more cultured.

Following extreme pollution events in the 20th century, Western societies became aware of the need to reduce the collateral damage caused by energy production, which led them to pass laws guaranteeing air quality. As a result, energy-intensive and polluting production activities were gradually separated geographically from the consumption of the goods produced. This separation, which initially took place at country level, has now expanded to a global scale. Today, it is countries in the Global South, particularly in Asia, that produce most of the goods and suffer the consequences. Initially, this shift in production tools led to rapid economic growth in some developing countries, coupled with heavy industrialisation and urbanisation. Today, these transformations are leading to intolerable situations and heightened public awareness, resulting in growing socio-political tensions.

Pollution without borders: climate, health, ecosystems, societies

The principles of thermodynamics are stubborn. Oxidising fuels to extract thermal energy produces waste. Combustion particles from this waste have properties and a life cycle that enable them to reach and impact all ecospheres. They are formed in fire, circulate in the atmosphere, are deposited on the surface of the cryosphere, pedosphere and hydrosphere, ultimately becoming buried in sediments. Along the way, they affect the physics, chemistry and biology of various environmental and human systems. They know no geographical, thematic, ecosystemic or sectoral boundaries, least of all those of the SDGs. Following the breadcrumb trail left by these combustion particles not only helps to guide us through the maze of the SDGs and their targets, but also highlights their interconnections and their "integrated and indivisible" nature. This exercise advances the 2030 Agenda by improving the global environment and limiting climate change, delivering benefits for health, ecosystems and societies, with particular emphasis on: 1) improving health and well-being by reducing premature death due to noncommunicable diseases (SDG 3.4), reducing death and disease from dangerous chemicals and air, water and soil pollution (SDG 3.9), and strengthening the capacity of all countries for early warning, risk reduction and management of health risks (SDG 3.D); 2) preserving the global environment by improving air quality (SDG 11); 3) reducing marine pollution and increasing the resilience of marine ecosystems (SDG 14); and 4) preserving terrestrial and



The relationship between air pollution and the Sustainable Development Goals.

freshwater ecosystems and halting and reversing land degradation and biodiversity loss (SDG 15). Furthermore, describing the multiple impacts of this pollution by adopting transdisciplinary approaches is essential to identifying the benefits of reducing emissions of atmospheric pollutants in order to raise awareness among the various stakeholders (SDG 17) and advocate a revision of our production and consumption patterns aimed at reducing emissions (SDGs 7 and 12). Lastly, given the inseparable link between air pollution and climate change, the desire to improve air quality for immediate health reasons is a powerful lever for optimising the fight against climate change, and in so doing circumventing the cognitive bias of distancing ourselves from future issues that seem so far away (SDG 13).

Reducing emissions: from science about sustainability to science for sustainability

The challenge facing scientists is to move from a science about sustainability – aimed at improving our understanding of how physical, chemical, biological and social systems function and how vulnerable they are to increasing

pressures – to a science for sustainability – aimed at supporting sustainable policies and positive social transformations. The main characteristic of this science is to build, on solid scientific foundations (data-based evidence), scenarios of likely futures depending on the path taken.

Since moral responsibility towards future generations is a driving force behind commitment to sustainability science, researchers have a duty to provide the scientific evidence needed to find a balance and continuity between satisfying the needs of today and those of tomorrow. The main challenge is to challenge the dominant economic model based on fossil fuels, and to propose new equilibria and tools. This commitment to sustainability science with its goal of helping to reduce emissions must follow a sequence of stages that can be summarised as follows: 1) increasing our knowledge of the nature, sectoral and geographical origins of pollutants (what and where do we clean up?), and their impacts on physical, chemical, biological and socio-political systems (why clean up?); 2) using this knowledge to develop scenarios for positive change (how do we clean up?) and assess the potential effectiveness of desirable and acceptable options (how effective are they?); 3) raising awareness among communities and decision-makers of the risks associated with inaction (where is the consensus?); and 4) providing support to define the transformative solutions required to achieve the objectives identified, and to monitor the effectiveness of the measures taken (what are the solutions?).

KEY POINTS

Because fine particle pollution from combustion affects all environmental and human systems, the only way to find sustainable solutions is to take a truly cross-cutting approach that does away with borders: a cross-ecosphere, cross-disciplinary, cross-SDG, cross-border approach. The good news is that air pollution is a disease with a known cure: reducing emissions will bring immediate benefits for humankind as a whole. This makes it both a complex cross-cutting challenge and perhaps an ambitious test case for our ability to engage successfully in sustainability science by following this breadcrumb trail.

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