

Urgent need for Emergency Care planning to respond to climate change and air quality crises

La imperiosa necesidad de programar la asistencia a urgencias, atendiendo al cambio climático y las crisis de calidad del aire

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Climate change and the global crisis in air quality are phenomena that are having impacts on numerous aspects of society, including healthcare in general and emergency services in particular. In 2021, the World Health Organization declared that climate change is “the greatest threat to health facing humanity”,¹ which is why this organization issued new air-quality guidelines recommending drastic reductions in ambient air-pollution levels. Recently, and in relation to the meteorological scenarios we are experiencing within this new climatic reality, the UN Secretary-General stated that “humanity has opened the gates of hell”.²

Industrialization and the inappropriate use of natural resources carried out by humans over the last two centuries—and at an accelerated pace over the past five decades—has brought with it a drastic increase in the emission of gaseous and particulate pollutants into the atmosphere. Some of these gaseous pollutants are the so-called greenhouse gases, mainly carbon dioxide (CO₂) and methane (CH₄), and to a lesser extent nitrous oxide (N₂O) and other minor gases, which trap infrared radiation emitted by the Earth's surface. The increase in concentrations of these greenhouse gases is causing a rise in global atmospheric temperature, this rise being one of the main causes of climate change. This climate change is associated with 1) changes in atmospheric circulation; 2) greater alternation of heat waves and cold waves at mid-latitudes; 3) altered precipitation patterns; 4) reduction of polar ice caps; and 5) the expansion of subtropical deserts toward higher latitudes, among other effects. Another group of gaseous and particulate pollutants (solid particles only a few microns in size that enter through the respiratory tract) are those that deteriorate air quality and cause health effects. Among these gases are carbon monoxide (CO), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), and tropospheric ozone (O₃), while respirable particulate matter

(size < 10 μm; PM₁₀) and alveolar particulate matter (size < 2.5 μm; PM_{2.5}) consist of a mixture of (i) soot, condensed hydrocarbons, metals, and sulfur- and nitrogen-containing compounds linked to combustion emissions, and (ii) dust from various sources (construction, road abrasion, or desert dust).

The concentrations of pollutants that affect air quality vary notably over periods of only a few days, depending on daily emissions and, above all, on meteorological conditions. Variations in wind speed, vertical atmospheric stability, or the arrival of polluted air from other regions can cause concentrations of these pollutants to vary, within a few days, by between 50% and 500%. Studies conducted in Europe, North America, and Asia have demonstrated that the usual variations observed in the concentrations of these pollutants (NO₂, O₃, PM₁₀, and PM_{2.5}) induce changes of between 5% and 40% in daily emergency-department visits for conditions such as asthma exacerbations in children and adults, atrial fibrillation, myocardial infarction, heart failure, or chronic obstructive pulmonary disease (COPD), among others.³

Climate change is giving rise to an increase in the frequency and intensity of extreme meteorological conditions,⁴ in a scenario in which episodes of severe cold are followed by abnormally high winter temperatures, while heat waves are becoming more frequent and intense between spring and autumn.⁵ The greater variability of extreme meteorological scenarios⁵ linked to climate change includes an increase in the frequency with which heat waves, cold waves, storms, and floods alternate—events that increase demand on emergency services due to direct injuries, climate-related illnesses, and exacerbation of pre-existing health conditions. A recent example was the flooding caused by Cyclone Daniel in September 2023, which, after inundating 25% of Greece's agricultural land, deviated anomalously southward and caused the rupture of 2 dams in Libya, floods, 11,000

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Figure 1. A (left): Access to the main entrance of *Hospital Gregorio Marañón* (Madrid, Spain), during Storm Filomena. B (right): Saharan dust storm at a ski resort.

deaths, more than 10,000 missing people, the devastation of metropolitan areas, and a paradoxical increase in health risks due to lack of potable water. Behind the severity of Cyclone Daniel was the enormous amount of water vapor emitted by the Mediterranean due to its abnormally high summer temperatures (close to 30°C).

Another case of extreme weather was Storm Filomena, which struck peninsular Spain in January 2021 with intense snowfall and abnormally low temperatures, plunging part of the country into absolute chaos,⁶ placing hospitals and emergency services in a very compromised situation, partly due to a lack of effective contingency plans and coordination among agencies responsible for responding adequately to such situations (Figure 1A).

Of note, the “super-calima” Saharan dust storms that affected the Canary Islands in February 2020 (Figure 2) and the Iberian Peninsula in 2022⁷. Calimas have historically been common in the Canary Islands (Spain), though not with the severity witnessed between February 22nd and February 24th 2020. The first registered super-calima in peninsular Spain occurred on 15–16 March 2022, when skies turned an ochre orange from Andalusia⁸ and air-quality levels were categorized as “extremely unfavorable” due to high concentrations of PM₁₀, severely affecting health (Figure 1B). Exposure to Saharan dust inflames the respiratory tract⁹ and is associated with increased cardiovascular mortality (including heart failure¹⁰) at a rate of 2% for every 10 µg/m³ increase in daily measured concentrations of PM₁₀¹¹. Of note, during these super-calima events, PM₁₀ concentrations exceeded 1,000 µg/m³.

The health effects of climate change are multiple and complex. High temperatures, extreme meteorological phenomena, and changes in precipitation patterns generate a multitude of indirect effects that impact health determinants such as air quality, access to potable water, food security and housing, and disease transmission.

One of the impacts with the greatest effect in Spain is the increase in morbidity and mortality associated with extreme temperatures. Heat waves will become increasingly frequent and intense and will disproportionately af-

fect the most vulnerable population groups—those older than 65 years, children, pregnant women, the frail or chronically ill, exposed workers, and people at risk of social exclusion.²

This scenario represents a threat to public health, since increases in mortality from cardiovascular and respiratory diseases are often observed in both hot and cold conditions.^{12,13} Although climate change is already here and is an unquestionable reality, we have not yet implemented adequate planning for its acute impact on the healthcare system, particularly in hospital emergency departments.

Evidence exists on the impact of meteorological factors such as temperature and atmospheric pressure on the morbidity and mortality of certain conditions. Sub-analyses of the EAHFE study (Epidemiology of Acute Heart Failure in Emergency Departments), as well as other studies published in recent years, demonstrate the relationship between climate and certain cardiovascular diseases.^{14–18} For example, temperature and atmospheric pressure are independently associated with the severity of heart-failure decompensations, with potential differential effects on the need for hospitalization and in-hospital mortality.¹⁴

In patients suffering acute coronary syndrome (ACS), high atmospheric pressure during the week preceding the event increases the risk of ST-segment elevation acute coronary syndrome (STEACS).¹⁵

The 2021–2030 National Plan for Adaptation to Climate Change² establishes, among its objectives for preventing its effects on human health:

- Identifying climate-change risks to human health and developing the most effective adaptation measures by integrating climate change into national health and environmental plans.
- Promoting preventive actions against health risks derived from extreme temperatures.
- Preventing health risks posed by infectious and parasitic diseases—vector-borne and non-vector-borne—favored by climate change.
- Identifying the impact of climate change on air quality and strengthening synergies between adaptation and mitigation measures in this field.



Figure 2. Photograph taken in Arrecife, Lanzarote (Canary Islands, Spain), on 22 February 2020 during the Saharan dust surge that affected the Canary Islands (author: Sergio Rodríguez).

– Preventing climate-change-related health risks in the workplace.

It is striking that this plan lacks specific objectives for emergency and urgent-care services, which will undoubtedly be responsible for providing rapid and appropriate responses to the health consequences of climate change.

The intensity of some extreme meteorological events—such as heat waves and floods—will continue to grow; therefore, it is essential that the health services of the autonomous communities and the Spanish Ministry of Health develop contingency plans. This is not simply a matter of issuing public warnings to stay at home, self-protect, or avoid exercising outdoors. Based on scientific evidence regarding the acute health impact of extreme events, these plans must include hospital emergency departments, either by reinforcing them or by facilitating their

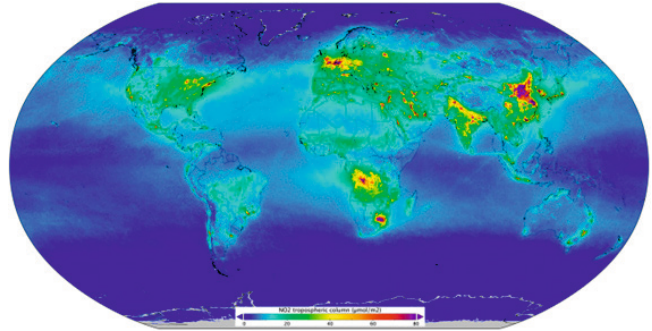


Figure 3. Global satellite image of nitrogen-dioxide concentrations from the European CAMS-Copernicus system. Data from the Sentinel-5P satellite sensor. Source: Copernicus-ESA.

patient flow, with anticipation of increased hospital-bed availability.¹⁹ Similarly, reinforcement of Primary Care Emergency Services and Emergency Medical Systems must be considered. The necessary information to implement this planning already exists, is free, and is available within public administrations. The European Union’s CAMS-Copernicus service (Figure 3) provides daily global air-quality forecasts, offering concentrations of each air pollutant as well as concentrations of Saharan dust. The Spanish State Meteorological Agency also has a dust- and sand-storm forecasting system, in collaboration with the World Meteorological Organization.

Therefore, the need for contingency plans in emergency services is increasingly evident—plans that allow an appropriate response to the foreseeable increase in demand in emergency departments during extreme-climate episodes that are becoming ever more frequent as a consequence of climate change, as well as a foreseeable increase in hospital admissions associated with these episodes, which can lead to collapse of these services.

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