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Silent Suffocation in Africa

Air Pollution is a Growing Menace, Affecting the Poorest Children the Most

Acknowledgements:

Report Prepared By: Nicholas Rees, Amy Wickham, Yoonie Choi
Oversight, Guidance and Direction: Gautam Narasimhan, David Anthony, Laurence Chandy
Analytics and GIS mapping: Jan Burdziej, Mac Glovinsky, Toby Wicks
Visual Communications: Shangning Wang

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Division of Data, Research and Policy
UNICEF
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Air pollution is a major killer of children, and accurately measuring air quality is key to effective responses. However, there is a severe dearth of reliable ground-level air quality measurements where many of the world's children live, particularly the poorest. The first in this series of reports looks at Africa, where our calculations indicate that about 6% of children live near reliable, ground-level monitoring stations that provide real-time data on the quality of air they are breathing - and it is likely that we are only scratching the surface in terms of understanding its full impact on children's health. This is compared to about 72% of children who live near reliable monitoring stations across Europe and North America. Increasing the base of reliable, local, ground-level measurements would greatly aid effective responses to this poorly-understood killer of children across the continent.

Air pollution is one of the biggest threats to children globally. Respiratory tract infections caused by air pollution resulted in over half a million deaths of children under five in 2016.[1] Air pollution doesn't just threaten children's survival, it can make them very sick, causing them to miss school and suffer from chronic infections that affect them well into adulthood. A growing body of research points to the impacts it can have on a child's brain development.[2]

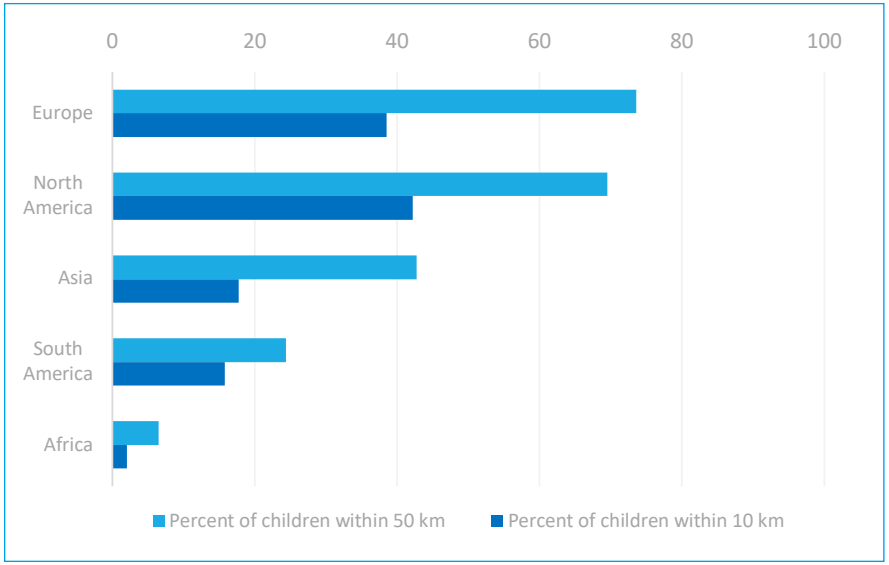
Children are uniquely vulnerable to air pollution – due both to their physiology, and to the type and degree of their exposure. Children's lungs are in the process of growing and developing, and the cell layer on the inside of the respiratory tract is more permeable among young children. Pregnant women are particularly susceptible to toxins contained in air pollution due to high level of cell proliferation and organ development. A disproportionatae share of child deaths from exposure to air pollution occur in low- and middle- income countries.[3]

Air pollution is a growing challenge for Africa. Deaths in Africa from outdoor air pollution have increased from 164,000 in 1990 to 258,000 in 2017 – a growth of nearly 60% (See *Figure 1*). Population growth, industrial growth and consumption growth have the potential to increase levels of pollution. Africa's 1.1 billion citizens will likely double in number by 2050, and more than 80% of that increase will occur in cities.[4] As cities grow, so too will traffic volumes. Compounding risks include imported old second-hand vehicles and increased use of two-stroke engines, which has increased in many cities over recent years.[5] Rates of economic growth in some African countries are similar to rates of growth in China and India before air pollution worsened significantly in these two countries.[6] With growing fossil fuel use, air pollution is likely to continue to get worse unless there is a transition to a more sustainable path of growth. The good news is that governments are already investing in solar and renewable energy for communities that are off-grid, improving prospects for a cleaner future.

However, while our knowledge on air pollution is growing, we do not know the full extent of the health impacts and epidemiology, especially in Africa. In part, this is due to considerable data gaps in reliable ground-level monitoring of air pollution where there are large and growing populations of children. *Figures 2 and 3* are maps of such ground-level monitoring stations around the world. Although there are stations in most countries and continents, there are very few in Africa. In fact, our calculations indicate that while up to 72% of children in Europe and North America live within a 50km radius of air monitoring stations, about 6% of children in Africa do. Moreover, compared to other regions, the number of African countries that have reliable, real-time air pollution monitors in the first place is significantly low: only seven out of 54 countries. This difference is as stark as it is alarming.

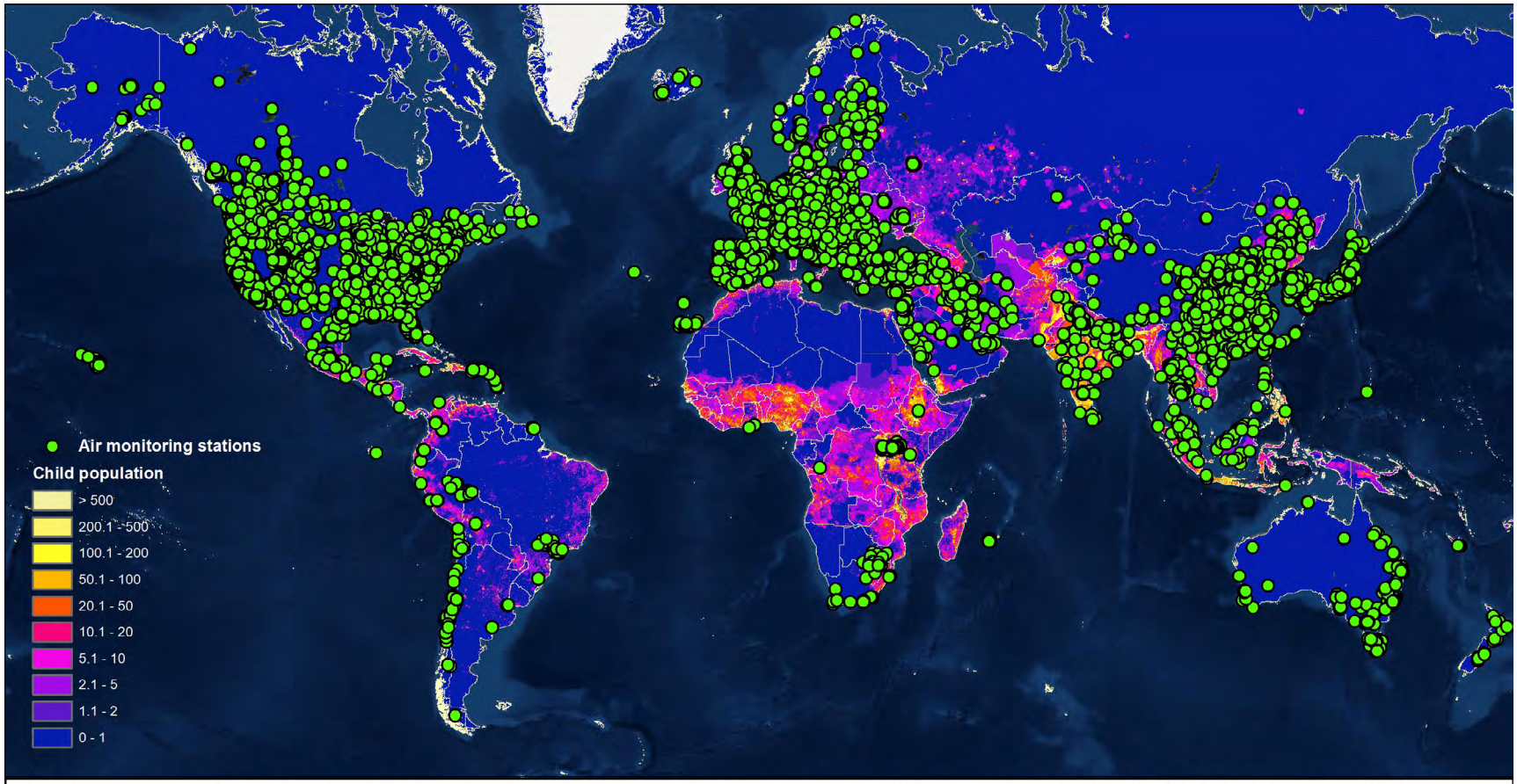
Figure 1: Only 6 per cent of children in Africa live near air monitoring stations

Percent of children within 10 and 50km of air monitoring stations (by continent), 2019



Source: CIESIN / UNICEF

Figure 2: Real-time air pollution monitoring stations globally



The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations. Map was compiled from various data sources and its accuracy can not be guaranteed. Data sources: Global air monitoring stations sourced from: https://waqi.info/, https://www.purpleair.com, https://www.airqo.net/. Population data: the Gridded Population of the World version 4 (GPWv4) data (CIESIN), United Nations World Population Prospects projections for 2015 (UNICEF). Background map: Esri (2019).

Figure 3: Air pollution monitoring in Africa

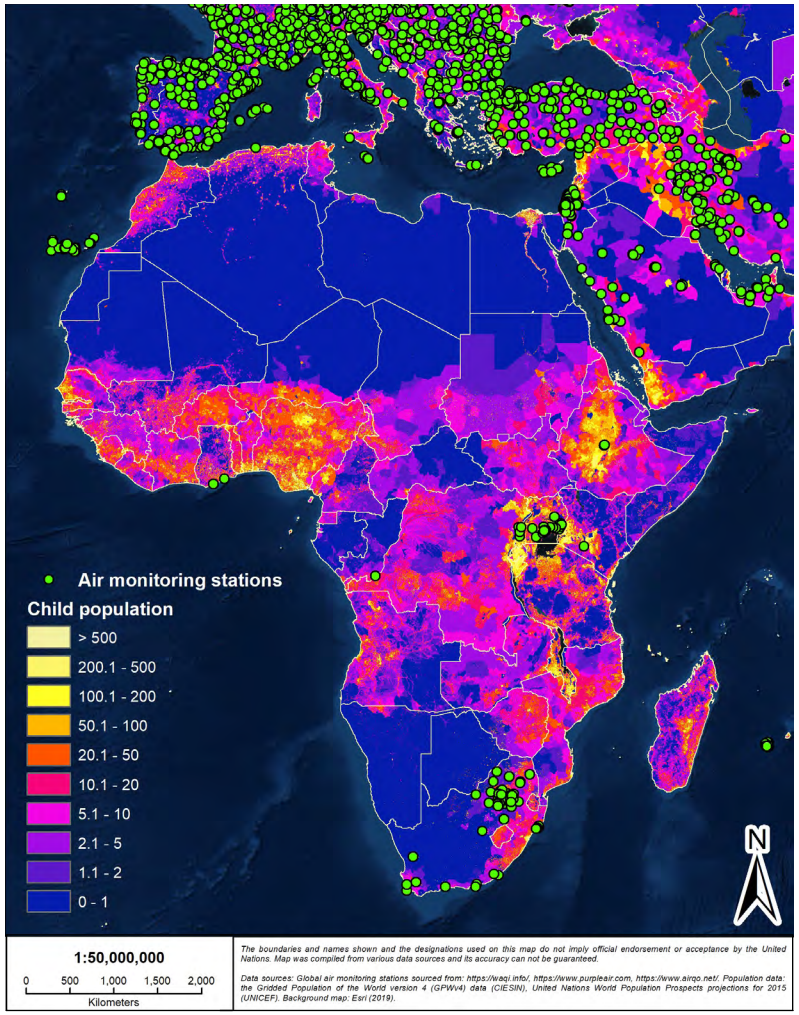
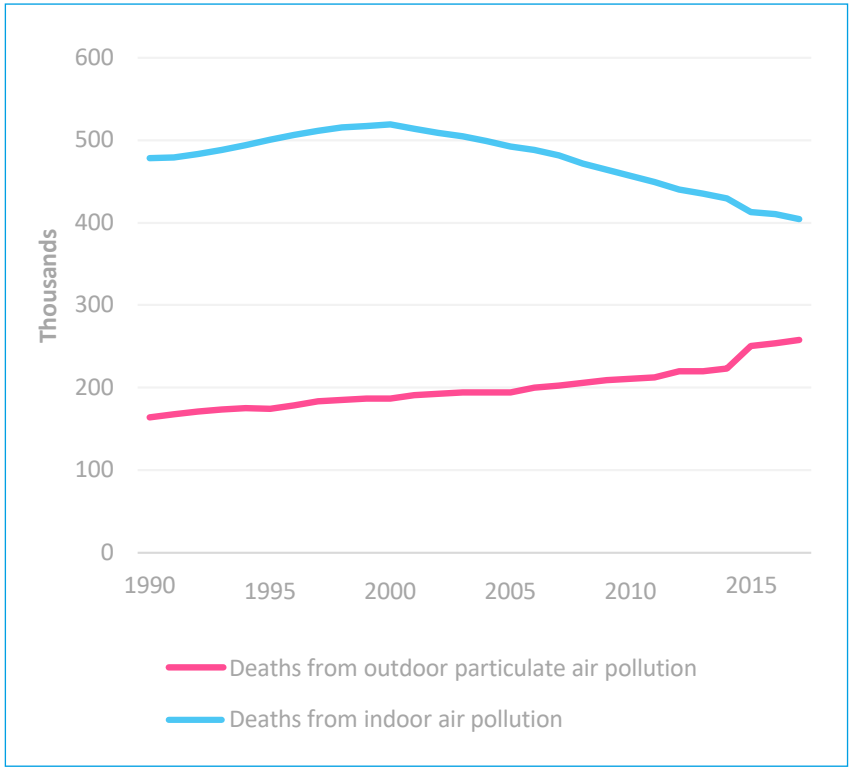


Figure 4: In Africa, deaths from indoor air pollution are declining whereas deaths from outdoor air pollution are increasing

Absolute number of deaths attributed to ambient (outdoor) air pollution, and to household pollution from cooking and heating (1990-2017)



Source: Institute of Health Metrics and Evaluation (IHME), Global Burden of Disease (GBD), 2017

Note: 'Deaths from outdoor air pollution' is defined as the absolute number of deaths by region attributed to ambient (outdoor) air pollution of particulate matter (PM). 'Deaths from indoor air pollution' is defined as the annual number of premature deaths attributed to household air pollution from the use of solid fuels for cooking and heating. 'Solid fuels' includes the use of crop wastes, dung, charcoal and coal for indoor cooking.

Children are Particularly at Risk from Air Pollution

Air pollution has been shown to greatly exacerbate risks to pneumonia and respiratory infections.[7] Children's respiratory airways are also smaller than adult airways, so infections are more likely to cause blockages than in adults.[8] Children breathe twice as fast, taking in more air per unit of body weight, compared to adults.[9]

Air pollution can also seriously affect the health of the foetus. Pregnant mothers are advised to avoid air pollution – just as they should avoid smoking or breathing secondhand cigarette smoke.[10] Studies have shown that chronic exposure to high levels of particulate matter (PM2.5 – which consists of particulate matter with a median diameter of less than 2.5 microns, approximately one thirtieth the width of average human hair) is associated with higher rates of early foetal loss, preterm delivery – and lower birthweight.[11,12] According to one recent study, a 10μg/m^3 increase in PM2.5 is associated with a 9 percent increase in infant mortality.[13] The researchers also estimate that even just a 5μg/m^3 decrease across Africa might have averted 40,000 deaths in 2015.[14]

Moreover, air pollution has been shown to impact children's growing brains. Ultrafine pollution particles are so small that they can enter the blood stream, travel to the brain, and damage the blood-brain barrier, which can cause neuro-inflammation.[15,16] Some pollution particles, such as ultrafine magnetite, can enter the body through the olfactory nerve and the gut, and due to their magnetic charge, create oxidative stress – which is known to cause neurodegenerative diseases.[17] Other types of pollution particles, such as polycyclic aromatic hydrocarbons, can damage areas in the brain that are critical in helping neurons communicate, the foundation for children's learning and development.[18] A young child's brain is especially vulnerable because it can be damaged by a smaller dosage of toxic chemicals, compared to an adult's brain.

The effect of air pollution has considerable broader social and economic impacts for Africa. A recent study estimated the economic cost of premature deaths from outdoor air pollution across Africa to be $215bn.[19] Air pollution also impacts ecosystems – vital to livelihoods and health – as well as food crops.[20]

Indoor air pollution confounds the risks even further: children living in places with bad indoor as well as outdoor pollution have little-to-no reprieve. Indoor air pollution in Africa is higher than anywhere else in the world (*Figure 5*).[21] Due to poor levels of modern energy access in rural areas, many people still burn wood and other biomass to cook or heat their homes. Almost two thirds of children in Africa (around 350 million) live in homes where solid fuels are used in cooking and heating.[22] While deaths from indoor air pollution have declined by about 15% since 1990, the overall number of deaths is still very high – at over 400,000 in Africa in 2017.

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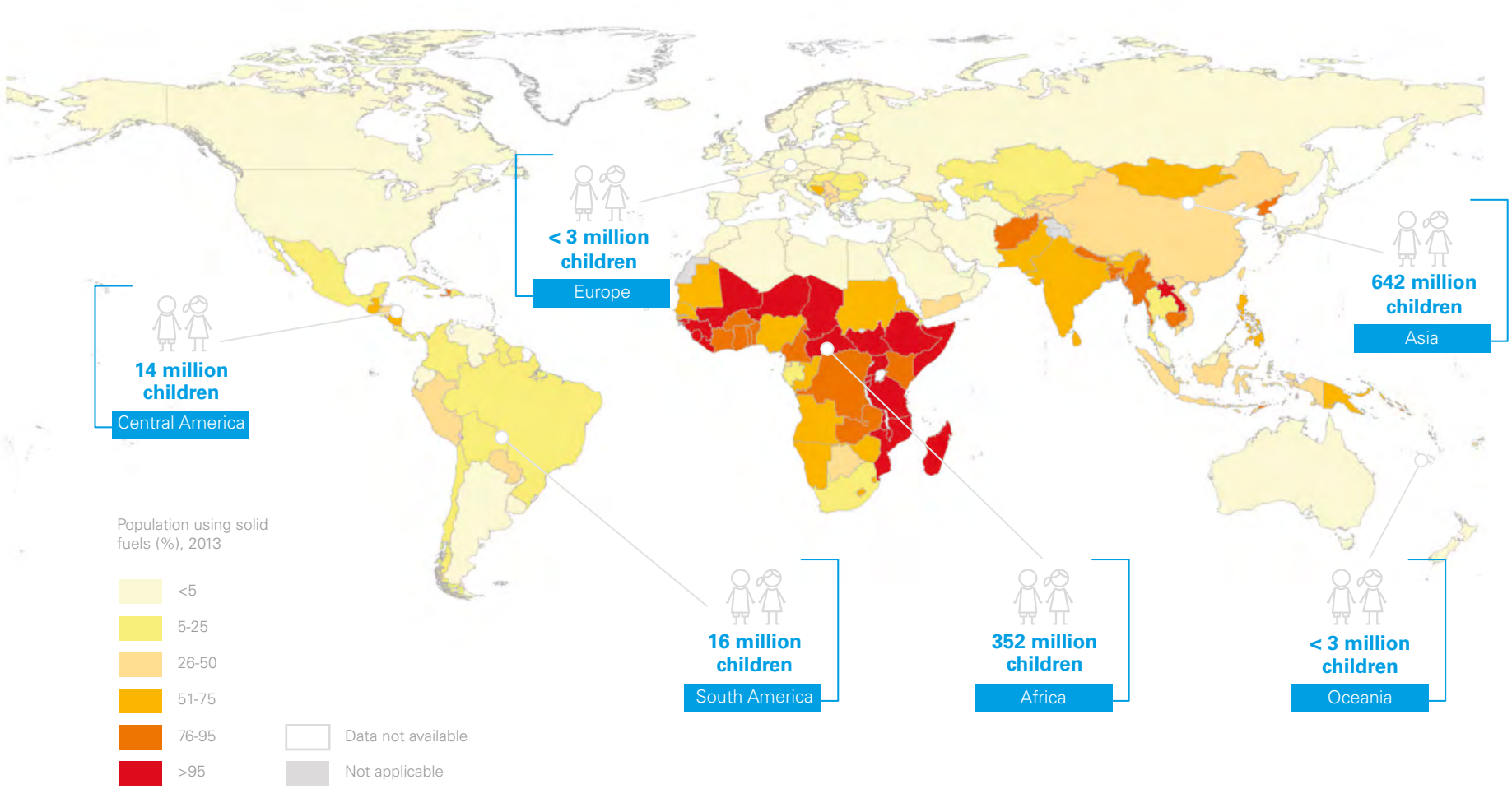
Figure 5: Over 1 billion children live in homes where solid fuels are used in cooking and heating

Population using solid fuels (%), 2013



These are only rough estimates for illustrative purposes. No age disaggregated data are available for population in households using solid fuels and therefore it is difficult to estimate the number of children in homes using solid fuels. These numbers were estimated by assuming that the proportion of children in a country using solid fuels is the same as the proportion for the total population. They are generated by taking the proportion of the population using solid fuels in every country and multiplying it by the number of children in the country from the United Nations Population Division. The number of children in households is likely to vary, which can bias the estimates. Solid fuels in rural areas tends to be higher and so too are the numbers of children per household, which is likely to result in an overall underestimate. Furthermore, countries where the proportion of the population using solid fuels is less than 5 per cent are not included, as a precise figure could not be obtained; and in countries where the proportion is greater than 95 per cent, 95 per cent is used. Furthermore, because women and children, especially young children, tend to spend more time near or around the kitchen than male adults, these numbers are likely to be underestimates of actual exposure levels of women and children.

Data Source: World Health Organization Global Health Observatory Data Repository

Map Production: Health Statistics and Information Systems (HSI),Global Health Observatory 2014

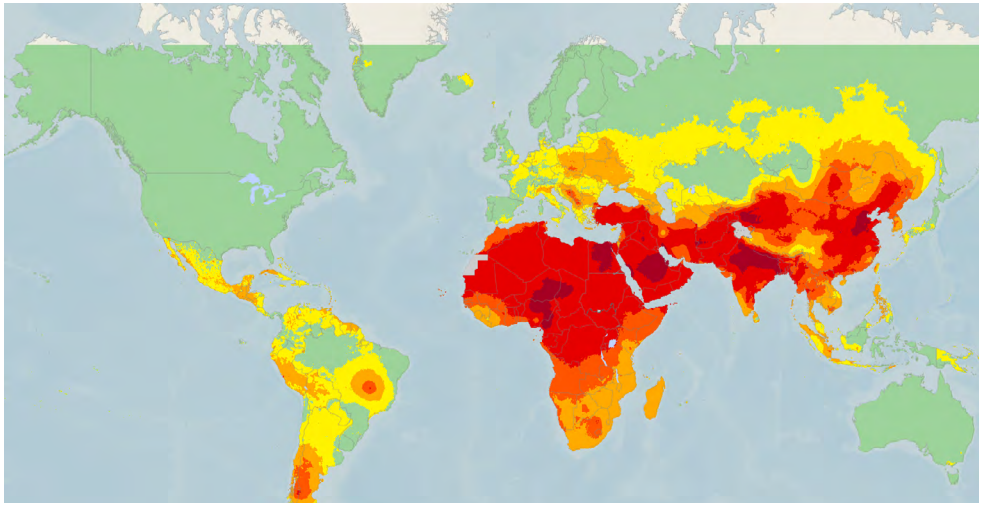
More Reliable Ground-level Monitoring of Air Pollution is Needed

Ground level real-time data helps to better capture the daily – even hourly – fluctuations in air quality. Ground-level real-time measurements are very important to improve public awareness, helping people to customize their behaviours and actions to both reduce air pollution as well as their exposure to it (i.e. through the provision of guidance to caregivers, pregnant women, health care providers and school and kindergarten staff about what can be done to reduce the risks). This monitoring is also very useful in identifying sources of pollution, shaping public health policy, and informing community level action and interventions that target the most affected. Ground level monitoring can also help provide data for epidemiological research which can determine how pollutants are impacting human health. A recent review of the role of environmental monitoring across air, soil and water quality in the United States indicate its crucial role in effective implementation of policy and programmes – including reductions in air pollution.[23] Technology advances have made ground-level data collection through lower-cost monitors increasingly accessible, but their reliability is significantly improved by having a high-quality 'reference grade' system in the vicinity for calibration.

Satellite-based remote sensing fills some of the gaps that cannot be addressed by local air quality monitoring (*see Figure 6*). Satellite imagery is becoming increasingly important for tracking long-distance air pollutant transport, filling in data gaps between monitors, and cross-checking ground-based emissions estimates and measurements. However, satellite-based remote sensing does not replace ground-based monitors, and in fact is often highly dependent on reference-grade ground-level measurements of air pollution to improve the accuracy of their estimates. Satellite remote sensing estimates pollution from satellite retrievals of Aerosol Optical Depth (AOD) – the degree to which light has been absorbed or scattered by particles in the atmosphere. Reference-grade ground monitoring stations are necessary to validate these estimates, by converting the AODs calculated from satellites into Particulate Matter (PM) concentrations. Ground level systems are also critical in determining and verifying the various types of pollutants in the air, including NOx, SO2, among others. Additionally, some limitations of satellite-based estimates include the effect of humidity, coarse spatial resolution[24], the effect of weather (i.e. snow, clouds, and dust) and complete topographies, as well as data capture not possible during darkness hours. Integration of satellite-based estimates with reliable ground-based measurements is therefore necessary to enable more accurate, precise, and complete information to provide an enhanced understanding of local and regional air quality.

Better air quality measurement is needed to better understand the full impact of air pollution itself.

Figure 6: Global Outdoor Air Pollution (PM2.5)



Source: World Health Organization 2018

Note: The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

A robust local air quality monitoring system is an essential component to managing air quality and reducing exposure. Best practice suggests an integrated measurement network made up of a reference grade ground monitoring station that can improve the accuracy of satellite measurements (to provide wide area coverage) and integrated with lower-cost air monitors (to detect hotpots and identify temporal variations). Such an integrated measurement network would provide the ability both to collect accurate, real-time local ground-level data as well as examine wider areas through satellite measurements.

Reference or Regulatory-grade monitors: Regulatory-grade monitors offer the most accurate air measurement source and form the backbone of any robust air quality monitoring programme. They are required to defensibly evaluate the variance of local air quality to prescribed guidelines (e.g. WHO limits), are required for ground truthing satellite estimates, and can be used to enhance the accuracy of low-cost monitors in the area by serving as a calibration point.

Low-cost sensors. Air pollution can vary from block to block in a city. Systems which can cover a variety of locations in a city offer tremendous opportunity. Low-cost sensors increase the coverage of air monitoring data for exposure assessment, identification of 'hotspots' and air quality advocacy and communication. The accuracy (and thus utility) of these low-cost monitors is enhanced by calibration with a reference-grade monitor.

Mobile and handheld devices. Mobile and handheld devices provide a lot of knowledge to individuals – including parents and children – about how bad the air is within their immediate vicinity. Mobile and wearable devices are extremely useful in helping adjust behaviour in order to reduce immediate exposure. These new devices are also low cost and are proving to be highly effective in crowd-sourcing data.

By building an integrated network of air quality monitoring systems in selected cities where there are none, through the installation of high-quality ground level monitoring systems, we can generate reliable estimates of local air quality data, a requirement to drive effective air quality policy design and response to reduce exposure to air pollution while serving as a powerful tool to inform the public about the dangers of air pollution.

Conclusion:

Because air pollution is not monitored in Africa to the same extent as other parts of the world, we are not only potentially underestimating the impact – we might also not know how bad it is until it is too late.

UNICEF urges local authorities and governments across the world to put in place systems that reliably monitor air pollution. UNICEF also urges the implementation of actions to reduce air pollution as well as children's exposure to it in the first place, including by:

- Investing in renewable sources of energy to replace fossil fuel combustion; providing affordable access to public transport; increasing green spaces in urban areas; cleaner cooking and heating solutions; and providing better waste management options to prevent open burning of harmful chemicals.
- Prevent children's exposure to air pollution, including by creating smart urban planning so that major sources of pollution are not located near schools, clinics or hospitals and minimizing exposure in the home.
- Improving children's overall health to improve their resilience. This includes the prevention and treatment of pneumonia, as well as the promotion of exclusive breastfeeding and good nutrition.

Action to address any problem usually begins with properly measuring it. It's time for us all to become more *air-aware*.

Endnotes

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