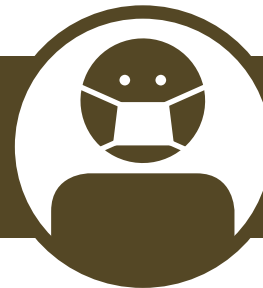


# AIR POLLUTION



ESTIMATES GLOBAL CARBON IMPACT

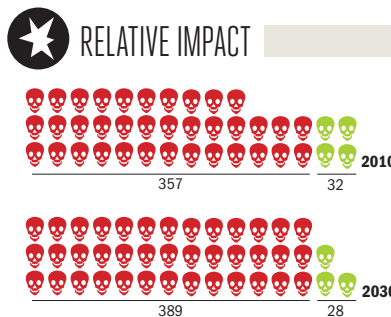
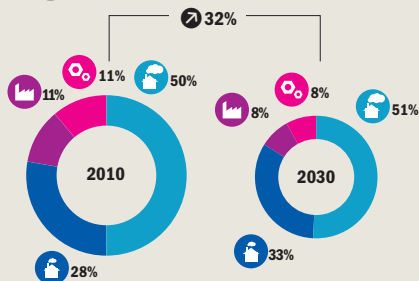
## 2010 EFFECT TODAY



## 2030 EFFECT TOMORROW



## MORTALITY IMPACT



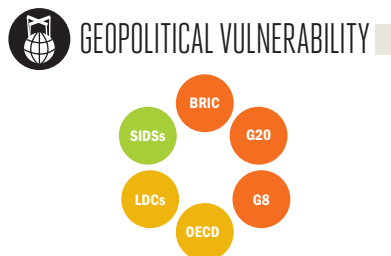
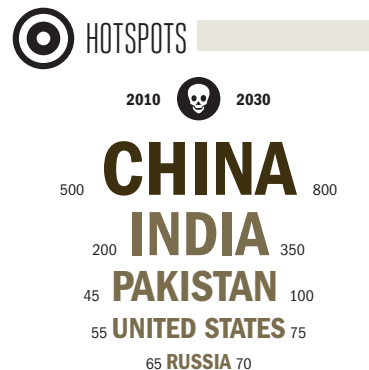
➤ Cities are home to over half the world's population and growing, all concentrated on only 2% of its surface area, producing 80% of all GHG emissions

➤ Where there are no strict emission controls, air contaminants from industry and transportation may become toxic and lethal

➤ Air pollution is a leading cause of death globally, triggering cancer, heart disease, and acute respiratory illnesses, and common asthma

➤ Technology and government regulation play a major role in making the air safer

➤ However, access to technology and capacity to implement regulation are lowest in parts of the developing world where air pollution is highest



Deaths

Developing Country Low Emitters

Developed

Developing Country High Emitters

Other Industrialized

= Deaths per million

Billion of USD (2010 PPP non-discounted)

Change in relation to overall global population and/or GDP

Preventing or reducing air contamination relies on a community's or region's determination to ensure safety and health. Technology, such as particle filters for vehicles, high quality refined fuels, and regulations on clean air are the main tools for limiting toxic emissions. Air pollution and its negative effects for health can and have been brought under control through these means in major economies of the world (Khan and Swartz, 2007). Although many developing countries have struggled to implement emission standards, they remain locked out of technological solutions for access, capacity, and financial reasons. However, some evidence for alternative regulation policies through incentives rather than penalties has demonstrated a potentially separate route (Blackman et al., 2010). Furthermore, low-tech responses, such as increasing urban tree cover, have also been proven to yield dividends for clean air (Nowak et al., 2006).

### HAZARD MECHANISM

Air pollution is caused when fossil or biomass fuels are burnt, often

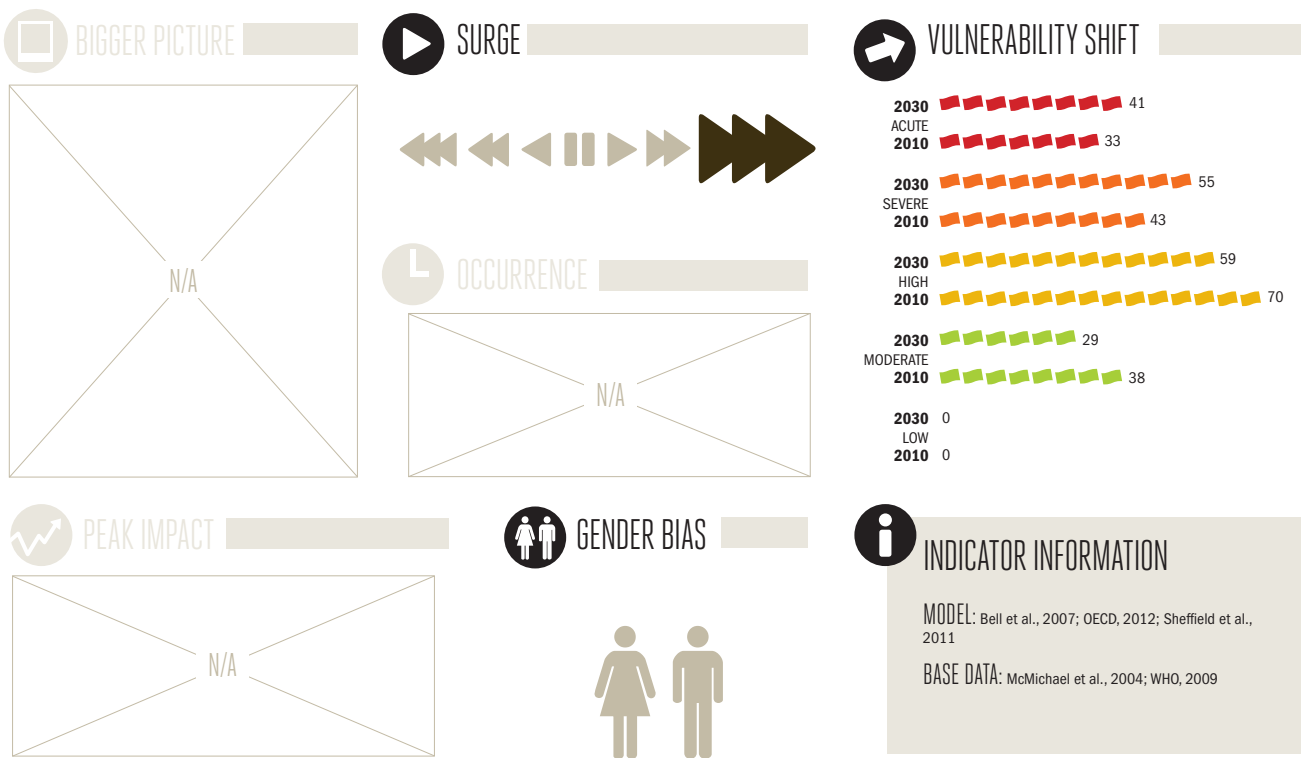
incompletely, by vehicles, in industrial settings, or through residential heating and cooking (Barman et al., 2010). These emissions contaminate the local environment at ground level, resulting in illness, which is dependent on the length of exposure to pollutants and the dose received (Hewitt and Jackson eds., 2009). Fine particles suspended in the air through these processes are small enough to be inhaled and represent a primary hazard. Research consistently shows a high rate of disease resulting from prolonged exposure to elevated levels of ambient air pollution, in particular due to heart disease, lung cancer, and respiratory illnesses, but also asthma and other illnesses such as allergies (World Health Organization (WHO), 2004; Cohen et al., 2005; Chen et al., 2008; Brook et al., 2010; Bell et al., 2007; Sheffield et al., 2011; D'Amato, 2011). Reducing particulate concentrations in areas of high pollution by around half can cut mortality by 15% (WHO, 2006). Experts have calculated that half a year of life is added for every 10 micrograms ( $\mu\text{g}$ ) fewer fine particulates (PM2.5) per cubic meter of ambient air, or a 1-2% increase in mortality rates for several major diseases per  $10\mu\text{g}/\text{m}^3$  more particulates (Pope et al.,

2009; Zanobetti and Schwartz, 2009). Currently, the global average of fine particle pollution is  $20\mu\text{g}/\text{m}^3$  (PM2.5). China's major industrial zones have the world's highest concentrations, at over  $100\mu\text{g}$  (PM2.5). More than half the population of East Asia currently exceeds the World Health Organization's  $35\mu\text{g}$  (PM2.5) uppermost safety limit (WHO, 2006). By comparison, recommended levels are below  $10\mu\text{g}$ , a full order of magnitude under China's lethal concentrations (Donkelaar et al., 2010). Urban residents of industrial centres in developing economies face the highest and fastest growing risks (Campbell-Lendrum and Corvalán, 2007).

### IMPACTS

Air pollution is estimated to kill 1.4 million people a year today in industrial and fast-emerging economies. That impact is expected to exceed 2.1 million deaths per year in 2030. Even as global population increases steadily over the next 20 years, deaths caused by air pollution are expected to grow as a share of population since the carbon intensive growth and urbanization, particularly of developing countries, exposes wider populations to toxic air environments (Hewitt and Jackson eds., 2009).

The most severe impacts are seen in former Soviet Union countries, such as Russia and the Ukraine, where heavy industrial emissions from the early 1990s, 1980s and earlier still contribute to high incidences of cancer, cardiopulmonary and respiratory illnesses. However, major emerging economies, especially China, Iran, and Pakistan have very similar and acute levels of vulnerability. Certain developed countries, such as Singapore and Greece, are highly vulnerable because they have important contemporary concentrations of small air particulates. Other advanced economies that have drastically cut pollutant levels, such as the UK or Latvia, also still experience an elevated disease burden from earlier periods of intense pollution. In terms of total impacts, China is estimated to account for nearly 800,000 deaths due to air pollution by 2030, with India half that level at around 350,000 deaths. Pakistan, the US and Russia would each suffer 70-100,000 deaths by 2030. Children are particularly vulnerable in particular to mortality resulting from acute respiratory illnesses worsened by high levels of particulate exposure, as well as other sicknesses (WHO, 2004; Nordling et al., 2008; Charpin et al., 2009).



● Acute ● Severe ● High ● Moderate ● Low

➡ = 5 countries (rounded)

Effects are widely felt, with over one hundred countries experiencing heightened impacts. But a large number of countries are also relatively unaffected, paradoxically as a result of either very low or very high development, which either rules out industrialization or facilitates tight constraints on emissions, respectively. Given the short time frame of the Monitor's analysis (to 2030) and the way in which the assessment is calculated, it is possible that impacts are underestimated for such newly industrializing countries as Bangladesh or Thailand, where mortality may not show up in national health data for five to ten years, or later, after the explosion of pollution effects.



## THE INDICATOR

The impact of air pollution is measured for four different diseases: acute respiratory illnesses, cardiopulmonary disease, lung cancer, and asthma. Regionally differentiated attributable risk factors from the WHO are relied upon for the first three diseases and an independent study for the asthma-related impact (WHO, 2004 and 2009; Bell et al., 2007). The Organization for Economic Co-operation and Development was referred to for projections of emissions and evolving impact, with mortality data from the WHO adjusted for 2030 in relation to expected economic development (OECD, 2012; Mathers and Loncar, 2005). The indicator is considered robust, due to the high quality of global analysis provided by the World Health Organization covering much of the impact estimated. The scientific basis for the cause-and-effect relationships involved have been rigorously studied for decades and are particularly well understood (Chen et al., 2008).

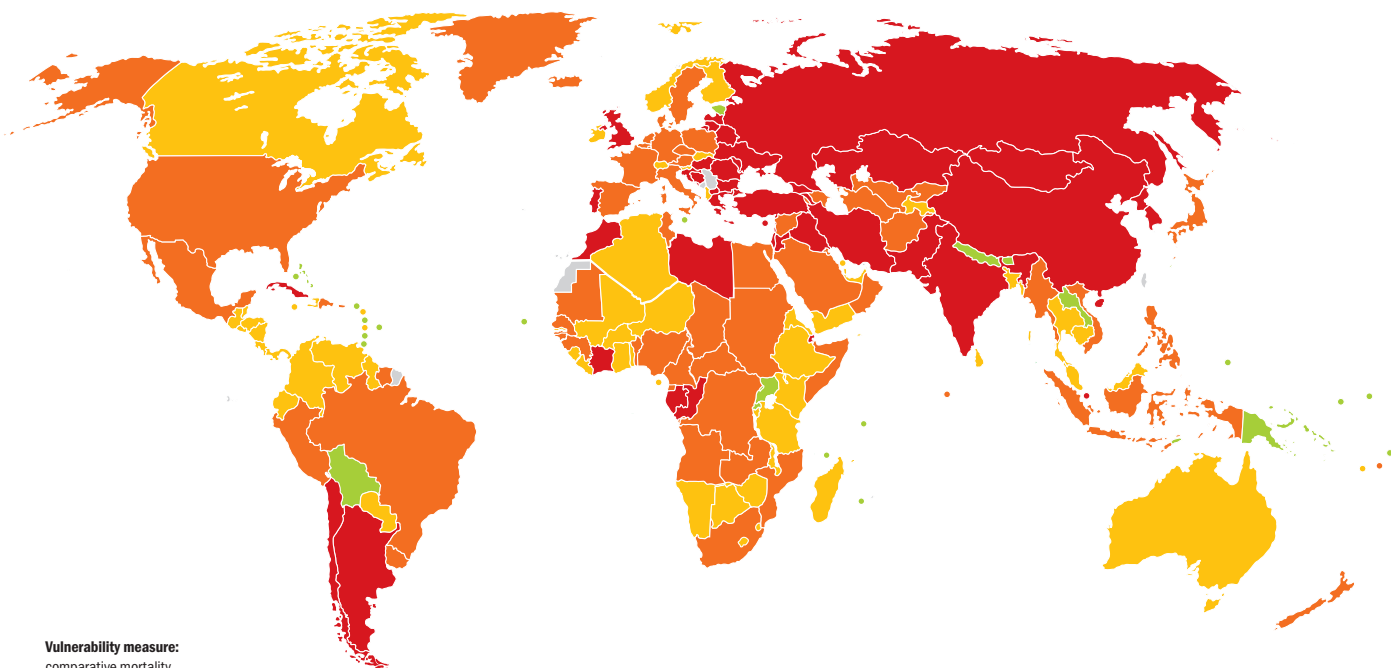
ESTIMATES COUNTRY-LEVEL IMPACT

COUNTRY	ACUTE		SEVERE		COUNTRY	ACUTE		SEVERE		COUNTRY	ACUTE		SEVERE	
	2010	2030	2010	2030		2010	2030	2010	2030		2010	2030	2010	2030
<b>ACUTE</b>					<b>SEVERE</b>									
Argentina	9,500	10,000	100,000	150,000	North Korea	6,000	7,000	85,000	150,000	Iceland	45	60	650	950
Armenia	2,000	2,000	20,000	30,000	Pakistan	45,000	100,000	400,000	1,000,000	Indonesia	30,000	55,000	600,000	2,000,000
Belarus	3,500	3,500	60,000	100,000	Portugal	3,000	3,000	40,000	50,000	Italy	10,000	10,000	150,000	200,000
Bosnia and Herzegovina	2,000	2,000	20,000	30,000	Romania	7,500	8,000	70,000	80,000	Japan	20,000	25,000	400,000	600,000
Bulgaria	4,000	4,000	35,000	35,000	Russia	65,000	70,000	900,000	1,000,000	Kuwait	350	500	6,000	15,000
Chile	3,500	4,500	35,000	55,000	Singapore	1,500	2,500	20,000	45,000	Kyrgyzstan	650	950	6,000	10,000
China	500,000	800,000	4,500,000	8,000,000	South Korea	10,000	15,000	300,000	600,000	Maldives	25	70	400	1,500
Congo	1,000	2,000	15,000	40,000	Turkey	25,000	35,000	300,000	450,000	Mauritania	500	900	8,000	25,000
Cote d'Ivoire	3,500	5,500	60,000	150,000	Ukraine	30,000	30,000	300,000	350,000	Mexico	15,000	20,000	200,000	300,000
Croatia	1,000	1,500	15,000	15,000	United Kingdom	15,000	15,000	200,000	350,000	Mozambique	3,500	5,500	55,000	150,000
Cuba	3,000	3,500	30,000	45,000						Myanmar	5,500	10,000	100,000	300,000
Cyprus	300	350	5,000	8,500						Netherlands	2,500	3,000	35,000	45,000
Djibouti	300	400	3,000	5,500						New Zealand	600	800	10,000	20,000
Gabon	350	600	6,500	15,000						Nigeria	25,000	45,000	350,000	850,000
Georgia	2,000	2,000	25,000	35,000						Oman	400	750	4,500	10,000
Greece	3,500	4,000	40,000	45,000						Peru	4,000	5,000	40,000	70,000
Hungary	2,000	2,500	25,000	30,000						Philippines	10,000	25,000	350,000	1,500,000
India	200,000	350,000	2,000,000	6,000,000						Poland	6,500	7,500	75,000	100,000
Iran	20,000	40,000	250,000	800,000						Saudi Arabia	4,500	8,500	75,000	200,000
Iraq	7,500	10,000	70,000	150,000						Senegal	1,500	2,500	20,000	45,000
Israel	2,000	3,000	25,000	45,000						Somalia	1,500	2,500	10,000	30,000
Jordan	1,500	2,000	15,000	30,000						South Africa	7,500	9,000	150,000	400,000
Kazakhstan	6,500	8,000	85,000	150,000						Spain	8,000	8,500	150,000	200,000
Latvia	1,000	1,000	10,000	15,000						Sudan/South Sudan	5,000	8,500	50,000	100,000
Lebanon	1,000	1,500	15,000	20,000						Suriname	95	100	1,000	1,500
Libya	2,500	3,500	25,000	45,000						Sweden	1,000	1,500	20,000	35,000
Lithuania	700	750	8,000	10,000						Syria	3,000	4,500	40,000	85,000
Macedonia	600	700	7,500	10,000						Tunisia	1,500	2,000	15,000	20,000
Moldova	1,500	1,500	10,000	15,000						Turkmenistan	650	1,000	15,000	35,000
Mongolia	600	750	4,500	6,000						United States	55,000	75,000	850,000	1,500,000
Morocco	6,500	9,000	65,000	100,000						Uruguay	650	800	9,000	15,000
										Uzbekistan	3,500	5,000	35,000	75,000



# CARBON VULNERABILITY

● Acute ● Severe ● High ● Moderate ● Low



**Vulnerability measure:**  
comparative mortality  
as a share of population  
(national)

COUNTRY	2010		2030		COUNTRY	2010		2030		COUNTRY	2010		2030		
	2010	2030	2010	2030		2010	2030	2010	2030		2010	2030	2010	2030	
Vietnam	10,000	20,000	200,000	550,000	Lesotho	150	200	5,500	20,000	Bahamas	10	15	550	1,500	
Zambia	2,000	3,500	40,000	150,000	Liberia	350	750	8,000	25,000	Barbados		1	150	350	
<b>HIGH</b>					Madagascar	1,000	2,000	20,000	65,000	Bhutan	1	5	450	2,000	
Albania	250	350	9,500	20,000	Malawi	1,000	2,000	20,000	60,000	Bolivia	5	15	5,000	15,000	
Algeria	2,000	3,000	65,000	200,000	Malaysia	2,000	4,500	35,000	100,000	Cape Verde	10	20	1,000	4,500	
Australia	1,500	2,000	45,000	95,000	Mali	800	1,500	15,000	45,000	Comoros	25	45	1,500	5,000	
Bahrain	75	100	1,500	3,000	Namibia	150	250	5,500	20,000	Estonia	1	1	800	1,500	
Bangladesh	9,500	20,000	200,000	700,000	Nicaragua	300	450	4,000	10,000	Grenada			25	65	
Belize	15	15	200	400	Niger	650	1,500	10,000	35,000	Kiribati	1	1	400	1,000	
Botswana	150	250	5,000	15,000	Norway	500	600	15,000	25,000	Laos	150	300	4,000	15,000	
Brunei	15	35	500	1,500	Panama	200	250	3,000	5,000	Luxembourg	15	25	550	1,500	
Burkina Faso	1,000	2,000	20,000	60,000	Paraguay	300	500	4,500	9,000	Malta		1	450	1,000	
Burundi	350	700	15,000	60,000	Qatar	100	150	1,500	2,000	Marshall Islands			1	150	500
Cambodia	650	1,500	25,000	100,000	Saint Vincent	10	10	100	200	Mauritius	5	15	2,500	10,000	
Canada	2,500	3,000	45,000	80,000	Sao Tome and Principe	15	30	350	1,000	Micronesia			100	350	
Colombia	5,000	7,000	55,000	90,000	Sierra Leone	550	950	8,500	25,000	Nepal	650	1,500	30,000	100,000	
Costa Rica	250	300	3,000	5,000	Slovakia	500	550	6,000	7,500	Palau			15	40	
Dominica	5	10	150	350	Slovenia	200	250	3,000	4,000	Papua New Guinea	150	250	7,000	20,000	
Ecuador	850	1,000	9,500	15,000	Sri Lanka	900	2,000	65,000	250,000	Rwanda	350	550	9,500	30,000	
El Salvador	450	600	8,500	20,000	Swaziland	50	80	5,000	20,000	Saint Lucia		1	100	300	
Eritrea	250	500	7,000	25,000	Switzerland	850	950	15,000	25,000	Samoa		1	150	450	
Ethiopia	3,500	6,500	100,000	400,000	Tajikistan	300	450	4,000	10,000	Seychelles		1	150	650	
Finland	600	700	15,000	20,000	Tanzania	3,500	6,000	60,000	150,000	Solomon Islands		1	150	550	
Gambia	150	250	3,500	10,000	Thailand	4,500	8,000	75,000	250,000	Timor-Leste		1	5	600	2,500
Ghana	2,000	3,500	40,000	100,000	Togo	450	800	15,000	45,000	Tonga			100	300	
Guatemala	600	900	10,000	25,000	United Arab Emirates	600	800	8,000	10,000	Trinidad and Tobago		1	5	950	2,000
Guyana	85	80	1,500	2,000	Vanuatu	10	15	250	700	Tuvalu			15	50	
Haiti	900	1,000	10,000	25,000	Venezuela	3,000	4,500	35,000	55,000	Uganda	700	1,500	35,000	100,000	
Honduras	600	900	15,000	30,000	Yemen	1,500	4,000	20,000	50,000						
Ireland	200	250	5,500	10,000	Zimbabwe	1,500	2,000	15,000	45,000						
Jamaica	300	400	4,000	7,500	<b>MODERATE</b>										
Kenya	2,000	3,000	40,000	100,000	Antigua and Barbuda	1	1	55	100						