MENINGITIS

ESTIMATES GLOBAL CLIMATE IMPACT

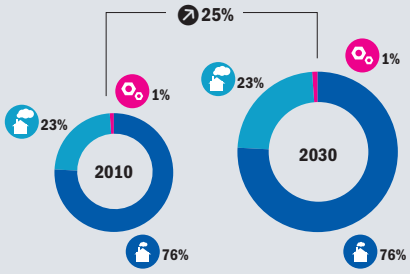
2010 EFFECT TODAY

DEATHS PER YEAR **30,000**

2030 EFFECT TOMORROW

DEATHS PER YEAR **40,000**

MORTALITY IMPACT

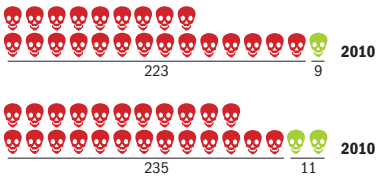


CONFIDENCE **SPECULATIVE**

SEVERITY	
AFFECTED	
INJUSTICE	
PRIORITY	
MDG EFFECT	

- Meningitis is growing worldwide and claims around 350,000 lives a year
- Humidity levels, wind, and dust are linked to outbreaks of the disease, factors actively influenced by climate change
- A "meningitis belt" stretches across northern Sub-Saharan Africa from Senegal to Ethiopia, sharing dusty and dry conditions, favouring meningitis
- Vaccines exist, but hundreds of millions of people living in risk areas around the world create a serious challenge for mass immunization
- Broader vulnerability measures, such as health education campaigns and improved sanitation will also be crucial

RELATIVE IMPACT

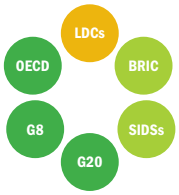


HOTSPOTS

2010 2030

6,500	INDIA	8,000
3,500	NIGERIA	5,250
2,000	DR CONGO	3,750
2,000	ETHIOPIA	3,000
800	TANZANIA	1,250

GEOPOLITICAL VULNERABILITY



Deaths
Developing Country Low Emitters
Developing Country High Emitters
Developed
Other Industrialized

= Deaths per 10 million

Change in relation to overall global population and/or GDP

Meningitis is a lethal and greatly feared disease in affected areas, because of the rapid onset of symptoms and serious risk of mortality, as well as high rates of infection—as many as 1 per 1,000 in parts of the African Sahel (Adamo et al., 2011). With mortality having more than doubled since the year 2000 and risks escalating as a result of climate change, mass inoculation is an attractive and life-saving component of any response to this growing challenge. However, beyond tackling the disease itself, it is also critical to address underlying vulnerabilities, such as over-grazing, soil degradation, deforestation, and the lack of adequate sanitation.

CLIMATE MECHANISM

The fact that meningococcal meningitis is largely a seasonal disease indicates the extent to which its prevalence is determined by weather-related parameters directly affected by climate change. Models that attempt to recreate meningitis epidemics show a high degree of success when calibrated with climate and environmental parameters. Meningitis epidemics are more likely to occur during the hottest, driest periods which are accompanied by high dust content in the air, and thus most likely to abate with the onset of the rainy season (Molesworth et al., 2006). The bacteria which causes meningitis is spread from person to person through coughing and sneezing, much like influenza or the common cold, and can be spread through poor sanitation (WHO, 2011; Schonning and Stenström, 2004). Bacteria can be present in a significant proportion of a population in areas affected by meningitis, but still remain benign.

Dust is a key trigger, because it damages the tissues of the nose and throat, facilitating the passage of pathogenic meningitis bacteria into the bloodstream (Thomson et al., 2009). Climate change affects both weather (heat, humidity, wind) and the environment (extent of vegetation or desertification) and can increase heat, dust, and wind, resulting in exposure and creating peaks of meningitis (Patz et al., 1996; Sultan et al., 2005). Climate change intensifies those factors that most determine meningitis outbreaks, particularly humidity (drought) and dust levels for areas that will become more arid (Sheffield and Wood, 2008; Prospero and Lamb, 2003).

IMPACTS

The global impact of climate change on meningitis is estimated to cause around 20,000 deaths a year in 2010, with 50,000 people affected. Some 30 countries are acutely vulnerable to the impact of climate change on meningitis exclusively in Africa, both inside and beyond the meningitis belt.

Least developed and landlocked countries of Africa are significantly more vulnerable than countries with even marginally higher levels of development. The largest impacts are estimated to occur in India, with nearly 7,000 deaths, and in Nigeria, the DR Congo, and Ethiopia, each of which is estimated to have an annual death toll in the thousands.

As incidence of the disease is rapidly increasing, it is expected to moderately expand through to 2030 and increase proportionate to population growth, claiming over 40,000 a year by 2030 with 80,000 people affected each year.

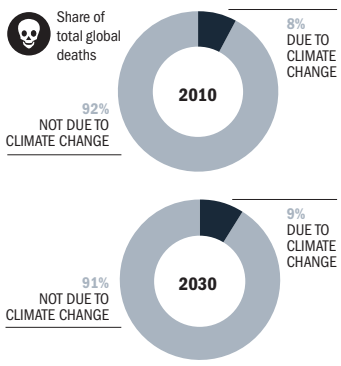
THE BROADER CONTEXT

Meningitis underwent explosive growth in the first decade of the 21st century, doubling from just over 150,000 deaths in 2000, to well over 350,000 deaths a year by 2008—this in spite of a dramatic increase in economic development during that period. Meningitis is one of the few communicable diseases to have rapidly expanded in the past decade (WHO BDD, 2011).

VULNERABILITIES AND WIDER OUTCOMES

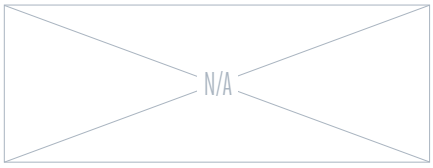
Pockets of environmental vulnerability to meningitis exist around the world, but outside of Africa, India makes up a large share of the remainder of the global burden of the disease. Environmental predispositions to meningitis are exacerbated through land degradation, such as deforestation, over-irrigation, and over-grazing—effects that also generate the dry and dusty conditions that are most favourable to meningitis (Nicholson et al., 1998). The incidence of meningitis is also closely related to cramped living conditions and poor sanitation, inadequate hygiene and access to water, since infection is carried through human contact, coughing, and sneezing (WHO, 2011). Levels of awareness and education can affect understanding of the disease and largely determine the measures taken by individuals to prevent contracting the

BIGGER PICTURE

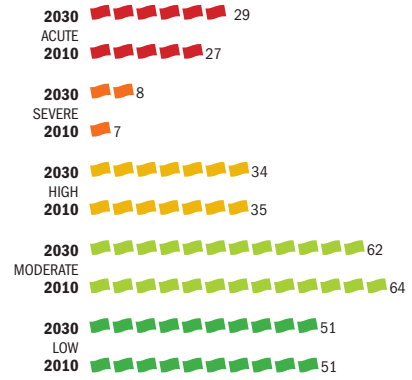


SURGE

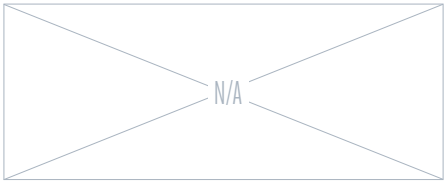
OCCURRENCE



VULNERABILITY SHIFT



PEAK IMPACT



GENDER BIAS

INDICATOR INFORMATION

MODEL: Adamo et al., 2011; Sheffield and Wood, 2008

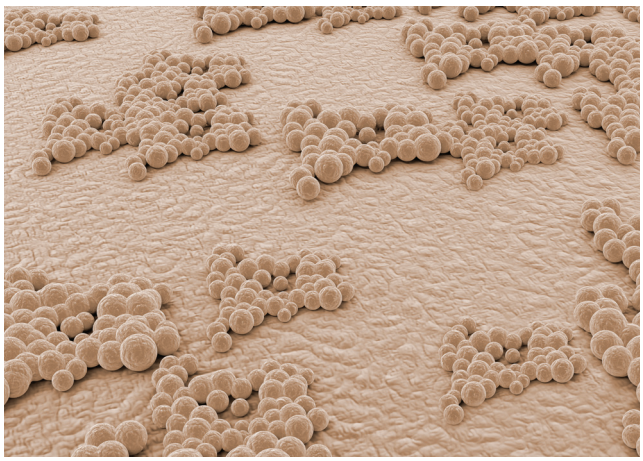
EMISSION SCENARIO: SRES A1B (IPCC, 2000)

BASE DATA: WHO BDD, 2011

= 5 countries (rounded)

Acute Severe High Moderate Low

disease (Nutbeam, 2000).
Given the high prevalence of meningitis among some of the world's poorest communities, the impact of climate change on the disease is a serious concern for human development progress (Arora, 2001). More tangibly, the increasing prevalence of meningitis with its high death rate among children—around two-thirds of all mortality—limits progress in lag regions towards the achievement of Millennium Development Goal 4, which aims to tangibly reduce child mortality (WHO BDD, 2011).



RESPONSES

Meningitis is one of the few major deadly infectious diseases affecting developing countries for which several effective vaccines already exist. Immunization is a particularly cost effective response. There are now several success stories in the fight against meningitis, where programmes have managed to significantly reduce the burden of the disease (Kshirsagar et al., 2007; LaForce and Okwo-Bele, 2011).
Given the large scale of the populations at risk—in Africa alone comparable to the entire population of the US—full breadth vaccination becomes prohibitively expensive, even using the lowest-cost solutions available. For this reason, response strategies to meningitis outbreaks have favoured early warning monitoring and vaccine interventions at the community level, when outbreaks of meningitis exceed a certain threshold (LaForce et al., 2007). Although newer, more effective meningitis vaccines are currently being disseminated in affected zones of the Sahel which promise to dramatically reduce the incidence of meningitis, it could take a full decade to provide them for the required numbers (Thomson et al., 2009).
Improving sanitation and living conditions, promoting education and awareness, and tackling environmental issues, including overgrazing, deforestation and land degradation will address the underlying causes of meningitis, in addition to ensuring the other well known benefits of such actions (DCPP, 2006; Nutbeam, 2000; Donohoe, 2003).

THE INDICATOR

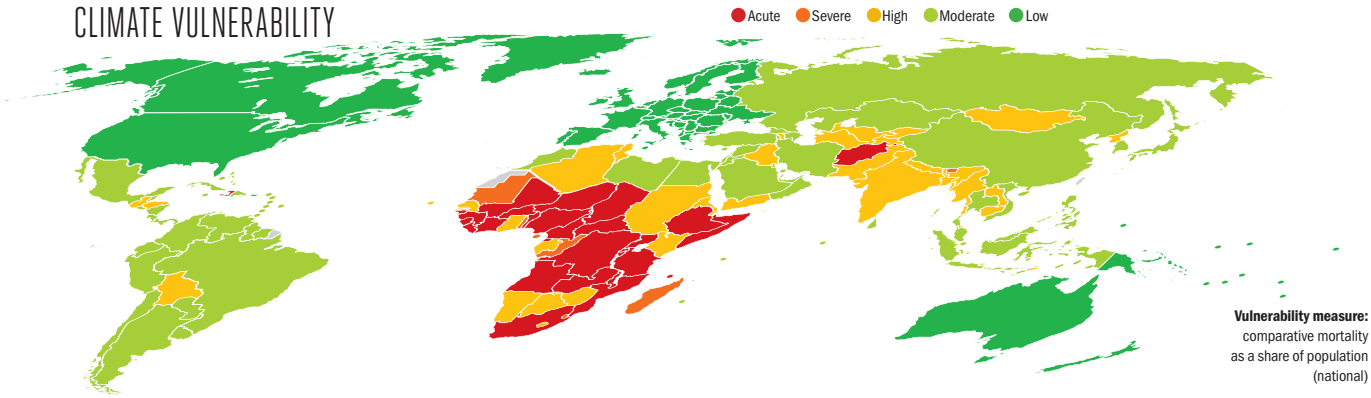
The indicator is a simple model that relates the incidence of meningitis to the incidence of drought. Global changes in the frequency of drought were linked to a meningitis risk model and population density, the indicator being highly sensitive to the latter, since close human contact is a major vulnerability driver for meningitis outbreaks (Sheffield and Wood, 2007; Adamo et al., 2011). The indicator then draws on the main WHO database to estimate how the current burden of meningitis evolves as drought incidence changes (WHO, 2011; WHO BDD, 2011). Uncertainty in relation to the climate effect is present due to the unpredictability of future rainfall patterns, a determining factor of drought.

ESTIMATES COUNTRY-LEVEL IMPACT

COUNTRY	2010	2030	2010	2030
ACUTE				
Afghanistan	500	850	850	1,250
Angola	500	900	1,250	2,500
Benin	250	350	350	600
Burkina Faso	300	600	500	950
Burundi	200	300	300	500
Cameroon	500	700	800	1,250
Central African Republic	90	150	150	200
Chad	300	550	500	850
Comoros	15	25	25	35
Cote d,Ivoire	450	600	700	1,000
DR Congo	2,000	3,750	3,250	6,000
Equatorial Guinea	15	25	50	85
Ethiopia	2,000	3,000	3,250	5,000
Guinea	250	400	400	600
Guinea-Bissau	65	100	100	150
Haiti	200	300	350	500
Liberia	90	150	150	300
Malawi	400	650	650	1,000
Mali	250	400	400	650
Mozambique	400	550	600	900
Niger	450	800	700	1,250
Nigeria	3,500	5,250	5,500	8,750
Rwanda	150	250	250	400
Sierra Leone	150	300	300	450
Somalia	150	250	250	450
South Africa	700	700	2,250	2,250
Tanzania	800	1,250	1,250	2,000
Uganda	500	900	800	1,500
Zambia	250	400	400	600
SEVERE				
Bhutan	5	10	10	15
Congo	40	75	65	100
Gambia	15	25	30	40
Madagascar	200	300	300	500
Mauritania	45	75	70	100
Sao Tome and Principe	1	1	1	5
Swaziland	10	10	25	35
Togo	65	100	100	150
HIGH				
Algeria	150	200	350	550
Armenia	10	10	20	25
Bangladesh	600	800	950	1,250
Bolivia	45	75	150	200
Botswana	15	15	45	55
Cambodia	100	150	200	250
Cape Verde	1	5	5	10
Djibouti	5	5	10	15
Eritrea	25	35	40	60
Gabon	10	15	35	55
Ghana	95	150	150	200
Guatemala	50	90	150	250
Honduras	20	35	55	90
India	6,500	8,000	10,000	15,000
Iraq	150	250	400	700
Kenya	200	300	350	450
Kyrgyzstan	20	30	35	50
Laos	50	65	80	100
Lesotho	15	20	30	30
Mongolia	10	10	15	15
Myanmar	250	300	400	500
Namibia	10	15	25	40
Nepal	100	200	200	300
North Korea	90	100	150	150
Pakistan	700	1,000	1,250	1,750
Senegal	100	150	150	250
Sudan/South Sudan	350	550	550	900
Tajikistan	55	80	85	150
Timor-Leste	5	5	10	10
Tunisia	45	60	100	150
Turkmenistan	25	35	60	95
Uzbekistan	90	150	150	200
Yemen	150	300	200	500
Zimbabwe	85	100	150	200
MODERATE				
Antigua and Barbuda				
Argentina	40	55	150	200
Azerbaijan	20	25	55	70
Bahamas			1	1
Bahrain	1	1	5	10
Barbados			1	1
Belize			1	1
Brazil	200	300	550	750
Brunei			1	1
Chile	10	15	35	50
China	800	850	2,000	2,250
Colombia	55	75	150	200
Costa Rica	5	5	10	15
Cuba	5	5	15	20
Cyprus			1	1
Dominica				
Dominican Republic	15	20	40	60
Ecuador	20	30	55	80
Egypt	200	300	500	800
El Salvador	10	15	30	45
Georgia	5	5	15	15

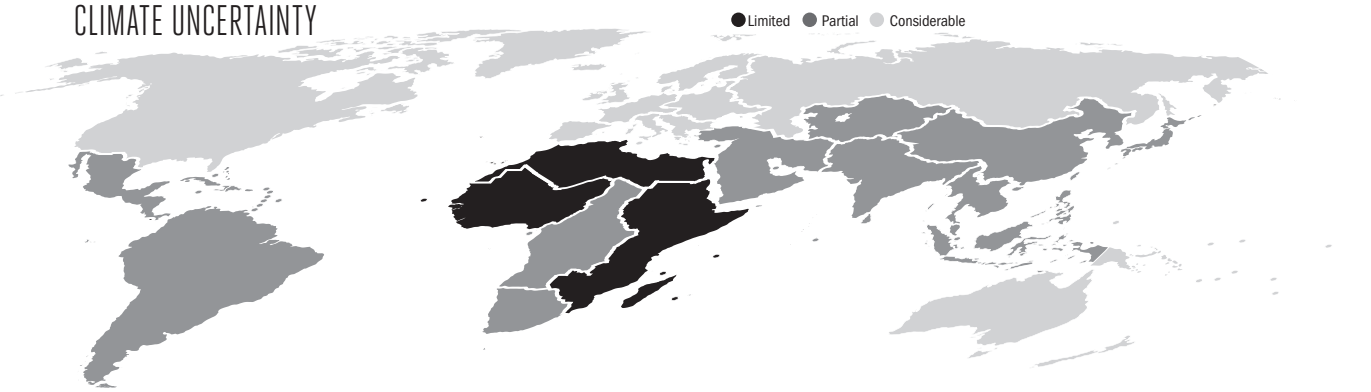
Additional mortality due to climate change - yearly average

CLIMATE VULNERABILITY



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

CLIMATE UNCERTAINTY



COUNTRY	2010	2030	2010	2030
Grenada				1
Guyana	1	1	1	1
Indonesia	550	650	1,500	1,750
Iran	65	90	150	250
Israel	1	5	25	35
Jamaica	5	10	15	20
Japan	25	25	250	250
Jordan	10	15	25	40
Kazakhstan	40	45	100	100
Kuwait	1	1	5	10
Lebanon	5	5	15	25
Libya	5	10	20	25
Malaysia	10	15	30	40
Maldives	1	1	1	1
Mauritius	1	1	5	5
Mexico	30	45	100	150
Morocco	40	55	100	150
Nicaragua	15	20	20	35
Oman	1	1	1	5
Panama	5	5	10	20
Paraguay	15	25	40	65
Peru	55	75	150	200
Philippines	200	250	500	650
Qatar			1	1
Russia	200	200	650	650
Saint Lucia			1	1
Saint Vincent				
Saudi Arabia	15	25	150	300
Seychelles			1	1
Singapore	1	1	5	5
South Korea	5	5	45	50
Sri Lanka	25	25	65	75
Suriname	1	1	5	5
Syria	30	50	80	150
Thailand	40	50	100	150
Trinidad and Tobago	1	1	5	5
Turkey	100	150	350	450
United Arab Emirates	5	5	30	45
Uruguay	1	5	10	10
Venezuela	25	40	85	100
Vietnam	70	85	100	150
LOW				
Albania				
Australia				
Austria				
Belarus				
Belgium				
Bosnia and Herzegovina				
Bulgaria				
Canada				
Croatia				
Czech Republic				
Denmark				
Estonia				
Fiji				
Finland				
France				
Germany				
Greece				
Hungary				
Iceland				
Ireland				
Italy				
Kiribati				
Latvia				
Lithuania				
Luxembourg				
Macedonia				
Malta				
Marshall Islands				
Micronesia				
Moldova				
Netherlands				
New Zealand				
Norway				
Palau				
Papua New Guinea				
Poland				
Portugal				
Romania				
Samoa				
Slovakia				
Slovenia				
Solomon Islands				
Spain				
Sweden				
Switzerland				
Tonga				
Tuvalu				
Ukraine				
United Kingdom				
United States				
Vanuatu				

Additional persons affected due to climate change (thousands) - yearly average