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.
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 DRCongo, 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
Given the 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, where 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).

### 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).

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### 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; Adame 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 present climate effect is present due to the unpredictability of future rainfall patterns, a determining factor of drought.