

# HEALTH IMPACT

Disease not disasters account for the vast majority of human deaths due to climate change. Higher temperatures and stress on water and food supplies do have serious impacts on human health, but changes in climate also enable some of the world's biggest killers – malnutrition, diarrhea, and malaria – to take a heavy toll. Mothers and children are worst hit by these illnesses.

2010  
CLIMATE EFFECT TODAY  
**350,000** DEATHS PER YEAR

2030  
CLIMATE EFFECT TOMORROW  
**840,000** DEATHS PER YEAR

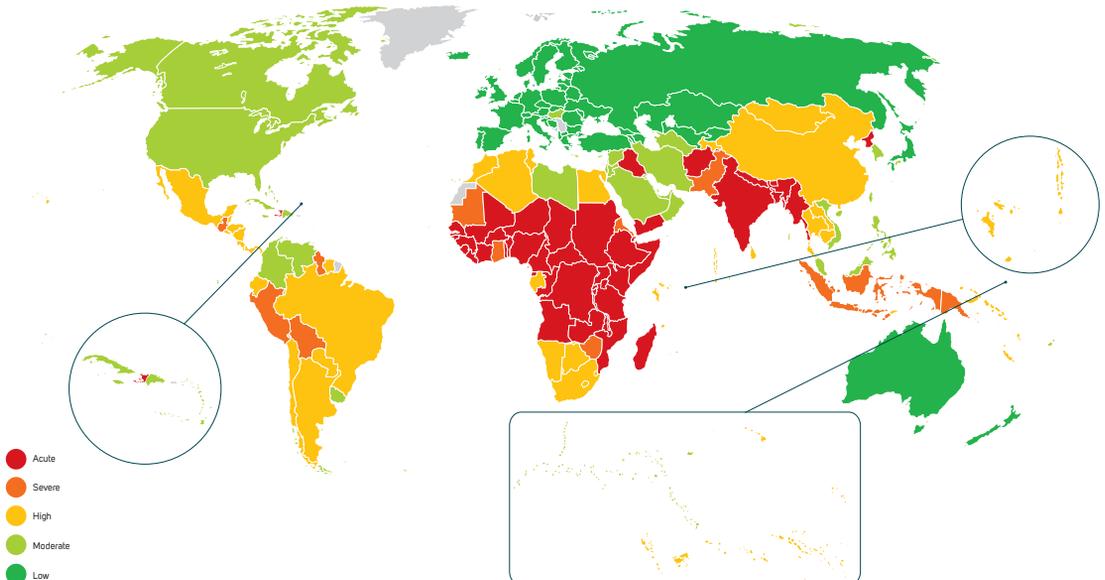
## FINDINGS

An estimated 350,000 people die each year due to major diseases and health disorders related to climate change. Unless measures are taken, by 2030 climate change will increase its toll to more than 800,000 deaths per year.

Vulnerabilities to diseases related to climate change are very unevenly distributed around the world but fall most severely on the shoulders of the poor and particularly affect the children of those vulnerable communities.

### GLOBAL VULNERABILITY TO CLIMATE HEALTH IMPACT

Countries by overall climate vulnerability for health

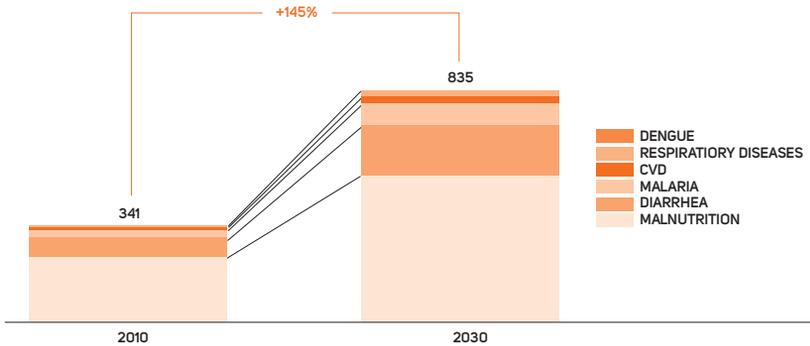


By far the majority of climate change-related deaths are due to malnutrition, diarrhea and malaria. These are already three of the greatest causes of avoidable deaths around the world, particularly in the poorest countries.<sup>19</sup> Climate change contributes to around 230,000 of the more than 3 million deaths attributable to malnutrition and acute respiratory infections each year. That number will increase to around

half a million by 2030. The next biggest killer associated with climate change is diarrhea, with some 70,000 out of 2 million deaths today, growing to around 190,000 deaths by 2030. Out of the 1 million deaths malaria now causes, some 25,000 are estimated to be linked to climate change, growing to 75,000 by 2030.

### GLOBAL CLIMATE HEALTH IMPACT BURDEN

The change in the scale of global climate-related health mortality from 2010 to 2030  
Additional Deaths (1000s) average per year

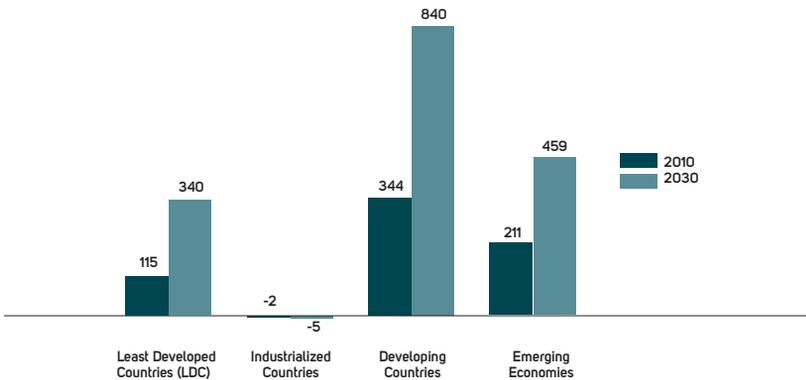


This progression is based on projections of increasing temperatures and other climate-related stresses over the next 20 years. It also incorporates population growth projections.

Least-developed countries will bear more than a third of this health burden, projections show. And developing countries are projected to bear practically the entire incremental disease burden due to climate.

### THE SPREAD OF IMPACT: MORTALITY

The distribution of climate-related health mortality by socio-economic group in 2010 and 2030  
Additional Deaths (1000s) average per year



These deaths are preventable, since an array of cost-effective measures exists, and in most countries with even moderately high income levels, there is no underlying burden of the main diseases that climate change reacts

with.<sup>20</sup> Poverty is therefore the main cause of the underlying vulnerability to these health problems as well as the greatest impediment to countering that vulnerability.

# IMPACT DYNAMICS

## CLIMATE AND HEALTH

The influence of climate on human health is widely researched and accepted.<sup>21</sup>

The impacts range from asthma through to influenza, vector-borne and waterborne diseases, heat-related deaths, and even mental health problems.<sup>22</sup>

This report's analysis builds on the detailed work in particular of the World Health Organization, including the development of climate change risk factors for headline diseases that have been subject to expert review and detailed discussions in academic publications, such as British medical journal *The Lancet*.<sup>23</sup>

The focus here is to outline the main causes of climate change-related health problems. In addition to malnutrition, diarrhea and malaria, those causes include respiratory and cardiovascular illnesses that react to high temperatures, and dengue fever, a vector-borne disease spreading in ways similar to malaria.<sup>24</sup>

Only mortality is used as an indicator for the climate-health assessment, and not, for example, morbidity or infection rates, because deaths offer us the most accurate means of measuring and projecting climate change impacts. The research examines linkages between climate vectors (such as temperature) and specific diseases, using techniques common to the health field to model estimated impacts and to guide interventions.<sup>25</sup>

PEAK IMPACT HEALTH ▲			
2003	Europe	Heat Wave	70,000 additional deaths - mainly among the elderly -1 of the 10 deadliest natural disasters in Europe in last 100 years <sup>26</sup>
2004	Indonesia	Dengue Fever	Over 58,000 infected, 658 deaths <sup>27</sup>
2006	India (northeast)	Malaria	25,000 infected, 50 died <sup>28</sup>
2008-2009	Zimbabwe	Cholera	98,741 infected and 4,293 deaths. Deadliest African cholera outbreak in the last 15 years <sup>29</sup>
2009	Bolivia	Dengue Fever	31,000 infected. A national emergency was declared <sup>30</sup>
2010	Haiti	Cholera	Death toll estimated at 442 as of November 2010 - first verified outbreak in the country <sup>31</sup>

## EXTREME HEAT

Heat and its relationship to disease stands out quite clearly. The extreme 2003 European heat wave resulted in some 70,000 more deaths than usual, mainly among elderly individuals who had already been suffering cardiovascular and respiratory illnesses.<sup>32</sup> Heat waves, of course, are expected to be more common in many areas as a result of climate change.<sup>33</sup> But hot, water-stressed countries – like many African nations – are in general more vulnerable than cooler, wetter regions.

These more vulnerable regions experience more than cardiovascular and respiratory diseases because of the heat. The higher temperatures and more humid climates caused by climate change favour bacteria growth and growth in the populations of insects and vectors that spread diseases.<sup>34</sup>

Insects such as mosquitoes breed faster in such conditions and can thereby spread illnesses more widely. Temperature may also accelerate the rate at which vectors (such as mosquitoes) replicate diseases within their bodies, so they become

infectious faster and spread diseases faster.<sup>35</sup> In the most extreme conditions of heat and water stress, however, mosquitoes can no longer thrive, and large-scale floods can wash away mosquito larvae.

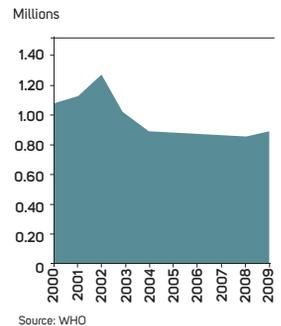
Malaria and dengue fever are expected to spread more widely.<sup>36</sup> The burden of vector-borne diseases will likely also spread to higher altitudes as mountainous zones warm up.<sup>37</sup> When diseases spread to communities unaccustomed to dealing with them, the health impact can be particularly severe, as local health systems and populations are ill equipped to respond.<sup>38</sup> The number of days or months of exposure are also expected to increase.<sup>39</sup> Yellow fever, not covered here, could react similarly to dengue and malaria.<sup>40</sup>

Water scarcity and water quality are important drivers of health. Less rainfall

VECTOR-BORNE DISEASES WILL LIKELY SPREAD TO HIGHER ALTITUDES AS MOUNTAINOUS ZONES WARM UP

FLASH FLOODS BRING SEWERAGE AND OTHER WASTE INTO CLOSER CONTACT WITH PEOPLE AND CONTAMINATE FRESH WATER SUPPLIES

## OVERALL DEATHS FROM MALARIA



causes problems in areas where drought and evaporation levels are on the rise, but more rainfall is problematic in areas where heavy rains or flash floods bring sewerage and other waste into closer contact with people and contaminate fresh water supplies.

Infections borne by food and water, such as salmonella and typhoid are expected to increase, including in Europe and North America.<sup>41</sup> Warming waters in coastal areas also favour the development of cholera bacteria.<sup>42</sup> The diarrhoea mortality indicator in this report measures some of the impact of these infections.

### HUNGER AND MALNUTRITION

Malnutrition, however, is the biggest challenge of all, since it is projected to account for the majority of deaths linked to climate change. Agriculture is highly sensitive to climate change, as discussed in detail in the Economic Stress section of this report. More variable and extreme weather, and changing rainfall patterns can reduce the local availability of food, heightening malnutrition rates especially among the poorest rural populations.<sup>43</sup>

Agricultural yields from key cereals are expected to suffer widespread decline by 2050, especially in poor countries, where marginal growing conditions mean fertility benefits from higher CO<sub>2</sub> on which plants feed, for instance, are unlikely to be realizable in practice.<sup>45</sup> Livestock will also suffer declines in many instances, since the grass or feed they are raised with is under stress too.<sup>46</sup> Subsistence farmers and other low-income groups with limited access to food supplies are likely already suffering from an added burden

of malnutrition in areas where rainfall has decreased and water scarcity and high heat are driving down local food production.

### FISHERIES

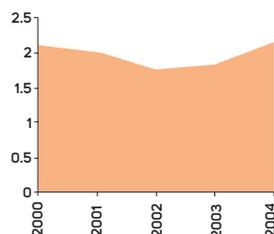
Impacts on fisheries are also contributing to malnutrition. Shifts in global fish stocks away from the tropics due to higher temperatures, coral bleaching, and increasing ocean acidity have already been established. These impacts are increasing the rate of malnutrition in affected communities that are heavily reliant on fish as their main source of food.<sup>47</sup>

While some regions will benefit from short- to medium-term improvements in agriculture, across fisheries, crops, and livestock, the global availability of food will be under increased stress due not only to climate factors, but also in large part to population growth and increasing demand.<sup>48</sup> And the local negative impacts of climate change are generally worst in regions already badly affected by malnutrition.<sup>49</sup>

The Adaptation Performance Review in this report demonstrates the wide array of extremely cost-effective measures that are readily available to any community with the resources and capacity to implement them. Millions of preventable deaths occur every year due to lack of access to these solutions.

The main climate-sensitive diseases – malnutrition, malaria and others – have been decreasing globally over the last decade. But climate change is compounding these key health problems just as significant resources are being invested into their eradication.

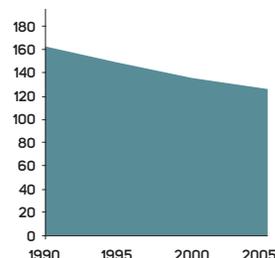
DEATHS FROM DIARRHEAL INFECTIONS  
Millions



Source: WHO

UNDERWEIGHT PREVALENCE

Millions preschool children



Source: International Journal of Epidemiology 2004;33:1260–1270

There is some evidence of a decreasing prevalence in overall global malnutrition rates in recent times, mainly due to sustained economic development and improved programmes combating this deadly health concern.<sup>44</sup> Climate change risks halting or even reversing that positive trend through increased drought, water stress and other climate shocks.

## LINKS FROM CLIMATE CHANGE TO IMPACT INDICATORS

CLIMATE CHANGE EFFECTS	PHYSICAL CHANGES	VULNERABILITIES	IMPACT INDICATORS
<ul style="list-style-type: none"> <li>• Changes in temperature</li> <li>• Changes in local rainfall</li> </ul>	<ul style="list-style-type: none"> <li>• Droughts</li> <li>• Increasing water pressure</li> <li>• Reduced crop yields</li> </ul>	<ul style="list-style-type: none"> <li>• Food security: Hunger / nutritional status</li> <li>• Lower respiratory infections</li> </ul>	<ul style="list-style-type: none"> <li>• Impact of malnutrition</li> <li>• Described as deaths related to malnutrition and lower respiratory infection due to climate change</li> </ul>
<ul style="list-style-type: none"> <li>• Changes in local rainfall and river run-off patterns</li> <li>• [Melting glaciers]</li> </ul>	<ul style="list-style-type: none"> <li>• Increasing water pressure</li> <li>• Inland floods</li> <li>• Coastal floods</li> </ul>	<ul style="list-style-type: none"> <li>• Diarrhoea</li> <li>• Access to clean drinking water</li> <li>• Access to basic sanitation</li> <li>• Water-borne diseases</li> </ul>	<ul style="list-style-type: none"> <li>• Impact of diarrhoea</li> <li>• Described as deaths related to diarrhoea due to climate change</li> </ul>
<ul style="list-style-type: none"> <li>• Changes in temperature</li> <li>• Changes in local rainfall</li> </ul>	<ul style="list-style-type: none"> <li>• Changes in environmental conditions for disease vectors</li> <li>• Floods / standing water</li> </ul>	<ul style="list-style-type: none"> <li>• Expansion of disease-endemic zones for vector-borne diseases</li> <li>• Increased transmission of malaria and other vector-borne diseases</li> </ul>	<ul style="list-style-type: none"> <li>• Impact of vector-borne diseases</li> <li>• Described as deaths related to malaria and dengue due to climate change</li> </ul>
<ul style="list-style-type: none"> <li>• Extreme thermal exposures</li> </ul>	<ul style="list-style-type: none"> <li>• More frequent extreme temperature events (heat and cold)</li> </ul>	<ul style="list-style-type: none"> <li>• Stroke</li> <li>• Asthma</li> </ul>	<ul style="list-style-type: none"> <li>• Impact of extreme heat events</li> <li>• Described as deaths related to cardio-vascular diseases and respiratory diseases due to climate change</li> </ul>

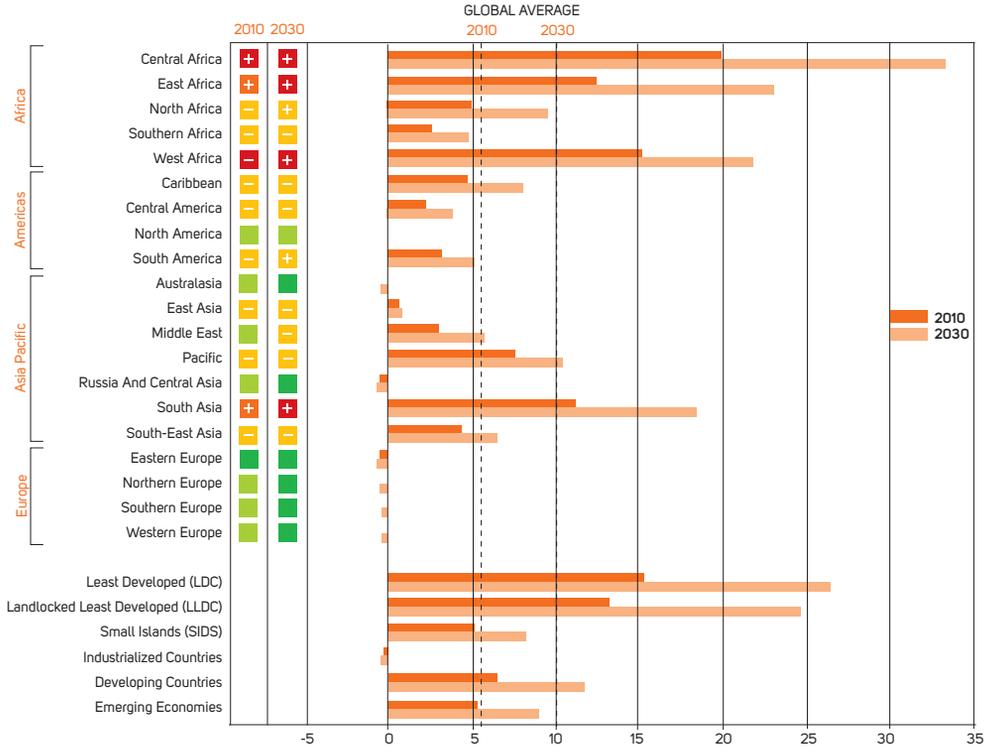
## WHO SUFFERS?

The world's poorest countries are the ones most vulnerable to the health impacts of climate change. They have the largest existing burdens of climate-sensitive diseases and the least effective public health systems.<sup>50</sup> A very large share of the burden of malaria, for instance, is experienced in Africa. Low-income

countries are also experiencing some of the most severe environmental changes that negatively impact health, such as extreme heat and water stress. The worst-affected regions are in Sub-Saharan Africa and Asia. The Pacific islands states are also projected to face significant additional disease burdens due to climate change.

## IMPACTS AROUND THE WORLD

The regional and socio-economic distribution of climate-related mortality relative to population in 2010 and 2030  
Deaths per 100,000, average per year



Due to the warmer, milder winters that climate change will bring to cooler countries, we will see low vulnerability to climate-related health problems expand across wealthy countries. An additional 45 countries will achieve low vulnerability by 2030 mainly for these reasons.

But any benefits these areas see are dwarfed by the costs to human life and well-being that low-income communities experience. Indeed, on current trends, the global human health impact is set to increase by more than 100% by 2030 if we do not take measures to counteract the growing negative effects of climate change.

Although Africa experiences the heaviest impacts of climate change on human health, Afghanistan ranks as the single most

vulnerable country to this type of climate impact. The landlocked, mountainous, relatively high-altitude country is one of the world's poorest, ranking in the bottom 15 countries of the UN Human Development Index.<sup>51</sup> Afghanistan has also been in a continual state of conflict since the late 1970s. Conflict and poverty disable the country's capacity to prevent and control this high disease burden. Without stronger action to contain this increasing burden, climate change could be responsible for claiming tens of thousands deaths in Afghanistan every year by 2030. Other highly vulnerable countries include

**GLOBAL HUMAN HEALTH IMPACT IS SET TO INCREASE BY MORE THAN 100% BY 2030**

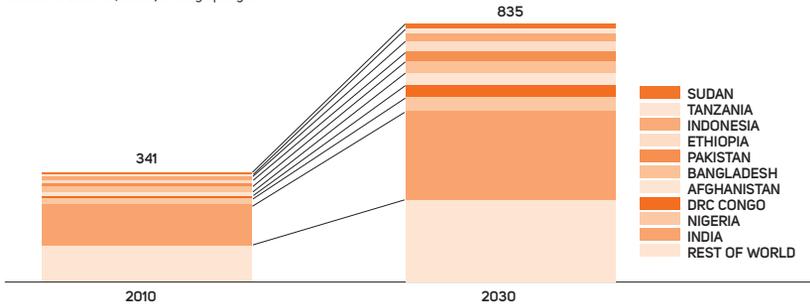
Somalia and a number of other post-conflict or conflict-prone countries, such as Sierra Leone, Angola, and the Democratic Republic of Congo.

### LEAST AFFECTED

There are many countries with very low vulnerability to the health impacts of climate change. Since measures to prevent death are so basic that most fatalities are due to poverty, wealthy countries see very few instances of the main climate-related killers, such as malnutrition or malaria.

### HOTSPOTS: MORTALITY

Countries with the largest total climate-related health impact by number of deaths  
Additional Deaths (1000s) average per year



There are also a few countries that reap a positive benefit from climate change on their public health. This is because the higher temperatures may reduce the prevalence of stroke, asthma, and other diseases.<sup>52</sup>

In absolute terms, India is the country that will face the highest number of excess Deaths due to the health impacts of climate change. It alone will carry more than a third of the total global health burden.

### WORST HIT AND LEAST HIT (2030)

The top 10 countries worst and least affected countries by the health impacts of climate change in 2030 relative to their size

WORST	LEAST
AFGHANISTAN	UKRAINE
SOMALIA	BULGARIA
NIGER	BELARUS
SIERRA LEONE	RUSSIA
DRC CONGO	ARMENIA
BURUNDI	MOLDOVA
RWANDA	ROMANIA
MALI	ESTONIA
MALAWI	LITHUANIA

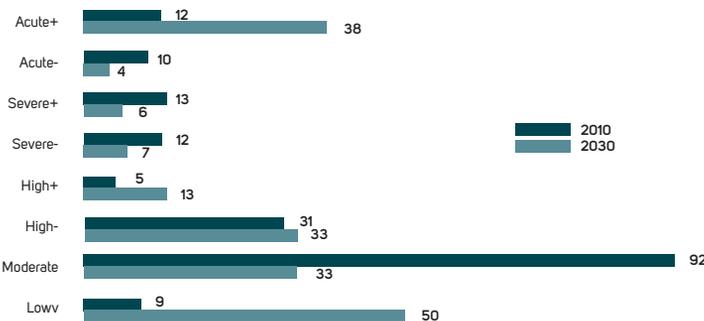
### THE IMPACT TOMORROW: 2030

The Monitor projects the health impacts of climate change to polarize over the next 20 years. The 50 worst-affected countries are projected to experience accelerating health

impacts. At the same time, the 50 least-affected countries are projected to experience very limited additional disease burdens, or even small benefits.

### VULNERABILITY SHIFT

The change in the number of countries by each Vulnerability Factor between 2010 and 2030  
Number of Countries by Vulnerability Factor



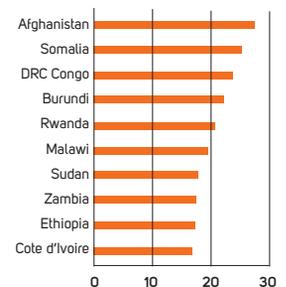
Almost every Sub-Saharan African region will become acutely vulnerable to climate change by 2030. This will also be the case for South Asia.

The countries whose vulnerability in this area is set to increase most rapidly are Afghanistan,

Somalia and DRC Congo. Nine of the ten countries projected to face the fastest surge in disease burden due to climate change are in Africa.

### HIGH SURGE VULNERABILITY

Countries with the fastest growing climate-related health impact between 2010 and 2030  
Percentage increase in impact



## SPOTLIGHT: DIARRHEAL INFECTIONS

The condition of excessive bowel movements, diarrhea, is another one of the biggest killers in developing countries today, responsible for around 2 million deaths per year. As with malnutrition, it almost never causes fatalities in wealthy countries. Diarrhea is also much less prevalent in developed countries where food and water contamination and spoiling are less common.<sup>53</sup> Most deaths brought on by diarrheal infections like cholera are the result of acute dehydration. Such deaths can be avoided with the simplest of treatments – a salt-water and sugar or rice-based drink called oral rehydration solution/therapy.<sup>54</sup>

Higher temperatures foster the growth of viruses, bacteria and parasites, which are passed on to people mainly via

food and water. Where refrigeration is limited, higher temperatures also increases the rate at which food spoils, forcing more people to eat food unfit for consumption. Increased flooding also threatens fresh water supplies. All of these problems can lead to diarrhea and death in the absence of basic treatment.<sup>55</sup>

Climate change is therefore estimated by the WHO to cause roughly 3.5% of the burden of diarrhea in many countries.<sup>56</sup> The 70,000 annual deaths this represents today are expected to increase to around 180,000 by 2030 unless proper measures are taken.

## THE ASSESSMENT

The Monitor assesses health impacts due to climate change by applying a sub-regional climate change risk factor developed by WHO to national climate-sensitive mortality statistics from 2004. WHO risk factors have been calculated for a range of different health concerns, such as smoking as a risk factor for lung cancer. Risk factors assume, for example, that climate change has a 3% role in a given burden of fatalities from a specific disease, such as malaria.<sup>57</sup> Regions such as Sub-Saharan Africa generally have higher risk factors compared to, say, North America, due to climate and other variables. But it is overwhelmingly the underlying burden of climate-sensitive diseases that plays the greatest determining role in whether a country is deemed to have a higher or lower factor of vulnerability to the health impacts of climate change. So countries where climate-sensitive diseases are more widespread have correspondingly higher factors of vulnerability. Mortality is assessed relative to total population, so impacts are assessed by their relative importance within a particular country.

There are nevertheless some surprising results from within Sub-Saharan Africa, which has the worst general burden of climate-sensitive diseases: Namibia (Moderate/Moderate), South Africa (Moderate/Moderate) and Zimbabwe (Moderate/High+) all have relatively low vulnerability,

especially in 2010. Each of these countries has a high rate of HIV/AIDS, which can assist the spread of vector-borne illnesses such as malaria.<sup>58</sup> But South Africa, for example, has almost no diarrhea, malaria, or dengue burden, and has malnutrition rates similar to many fast-growing Asian countries, such as Sri Lanka. Namibia also has very low malnutrition, diarrhea, and dengue rates, but has a higher burden of malaria.<sup>59</sup> While Zimbabwe registers relatively high on diarrhea and malnutrition death rates, it has no dengue and little malaria, and so is much less vulnerable than the norm for the region.<sup>60</sup>

Argentina (High-/High+) -- onetime breadbasket of the world -- receives a surprisingly high factor of vulnerability for health compared to its peers in South America. Driving the vulnerability is a high of number of deaths due to malnutrition. From 1999 to 2002 Argentina experienced a serious financial crisis with the economy contracting each year resulting in many instances of malnutrition especially among children in remote rural locations.<sup>61</sup> The Monitor bases itself on the most recent globally relevant health data available from the WHO, which was sourced for 2004, at the tail-end of this crisis. Argentina is generally expected to have improved its general situation since this time, minimizing a key vulnerability flare to climate change.<sup>62</sup>



A young boy eats locally grown rice in Philippines, May 2008. Source: VJ Villafranca/IRIN.