WEATHER DISASTERS

More extreme weather is observed today than was recorded 30 years ago. Wind, rains, wildfires, and flooding have claimed lives throughout human existence. Climate change is intensifying these phenomena, worsening floods, storms, and wildfires that kill people and destroy property and livelihoods. The most devastating impacts of extreme weather, in particular tropical cyclones, are concentrated in poor tropical and sub-tropical zones of the world. Extreme weather becomes a disaster when communities are unprepared or caught off guard. But most disasters can be relatively easily prevented when people have access to effective early warning systems and basic protection.

2010

CLIMATE EFFECT TODAY

3,500 DEATHS PER YEAR

4.5 BILLION DOLLAR IMPACT PER YEAR

2030

CLIMATE EFFECT TOMORROW

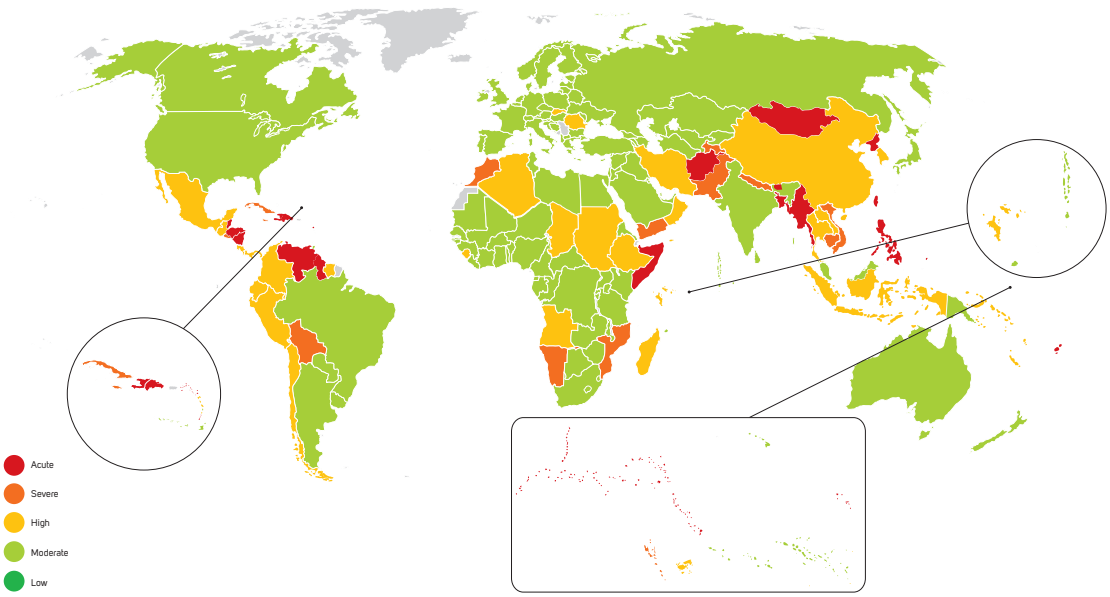
8,000 DEATHS PER YEAR

20 BILLION DOLLAR IMPACT PER YEAR

FINDINGS

GLOBAL VULNERABILITY TO CLIMATE WEATHER DISASTERS

Countries by overal climate vulnerability for weather



Climate change means more heat, warmer oceans, more evaporation, more energy, and either more or less rainfall. It also means more glacial and ice melt, often occurring more abruptly. Weather is becoming more unpredictable, with winds, storms, and rains changing patterns or tracks and intensities.[63] The tropical cyclone belts of Asia, the Caribbean, and the Pacific feel the worst impacts of floods, storms, and wildfires.

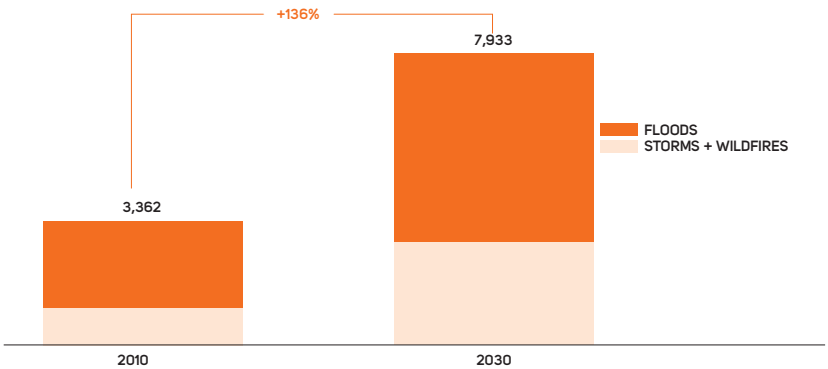
Floods, storms, and wildfires have claimed an average of 27,000 lives every year over the past 20 years.[64] Climate change is already estimated to contribute over 3,000 deaths to that toll each year. By 2030, climate change is projected to be responsible for over 7,000 such deaths if measures are not taken to reduce risks. The deadliest of these impacts today are floods. They are already estimated to claim 2,400 climate-driven deaths each year. And that figure will rise to more than 5,000 by 2030. Simultaneously, damage costs from weather disasters are projected to reach close to USD 5 billion each year already and to grow to USD 20 billion by 2030.

THE LARGEST ABSOLUTE LOSSES IN ECONOMIC TERMS ARE SEEN IN SOME OF THE WORLD'S WEALTHIEST COUNTRIES, INCLUDING THE UNITED STATES AND JAPAN

GLOBAL CLIMATE WEATHER DISASTERS IMPACT BURDEN: MORTALITY

The change in the scale of global climate-related weather disaster mortality from 2010 to 2030

Additional Deaths (1,000) average per year



People living in poor communities in developing countries are the most vulnerable to extreme weather. Yet some of the largest absolute losses in economic terms are seen in some of the world's wealthiest countries, including the United States and Japan.

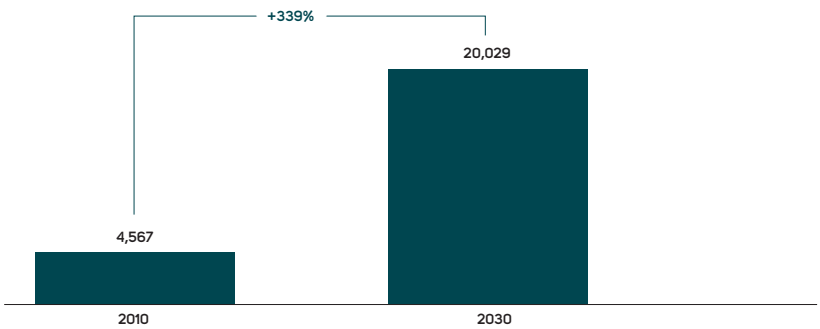
IMPACT DYNAMICS

Warmer atmospheric and ocean temperatures are being observed.[65] At the same time, observations of weather, especially via satellite, reveal an increase in flood events and suggest that tropical cyclones are increasing in intensity.[66]

GLOBAL CLIMATE WEATHER DISASTERS IMPACT BURDEN: DAMAGE COSTS

The change in the scale of global climate-related weather disaster damage costs from 2010 to 2030

Additional damage cost (million USD PPP) average per year



PEAK IMPACT WEATHER ▲

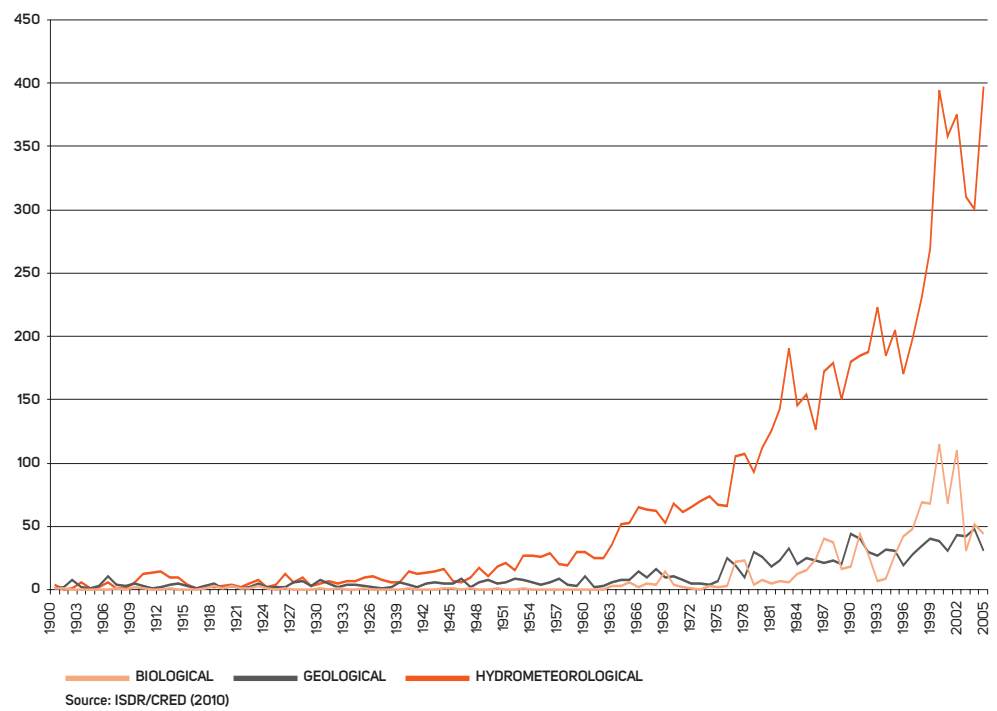
1998	Central America	Hurricane Mitch	18,811 deaths, more than 3 million affected-over $6 billion in damages[67]
2005	United States	Hurricane Katrina	1,833 deaths, 500,000 affected- $125 billion in damages[68]
2007	Bangladesh	Cyclone Sidr	4,234 deaths, 6 million left homeless - $2.3 billion in damages estimated[69]
2007	China	Flooding	Over 105 million affected and 535 killed - $4.4 billion in damages[70]
2007	Greece	Wildfires	5,392 affected- $1.7 billion in damages[71]
2007	USA (California)	Wildfires	292,098 ha burned, 24 killed, 120,000 displaced and $2 billion in damages[72]
2008	Myanmar	Cyclone Nargis	138,366 deaths - losses of $10 billion estimated[73]
2009	India	Flooding	992 killed, 1.9 million affected, and $220 million in damages[74]
2010	Pakistan	Flooding	Over 20 million affected, 2,000 killed -$9.5 billion in damages[75]
2010	Russia	Wildfires (from record temperatures and drought)	Cost $15 billion in damages - twice the average number of deaths due to heat wave and smog from fires[76]

RAINFALL AND CYCLONES

Rainfall is becoming heavier in North and South America, Northern Europe, and Central Asia.[77] This kind of heavy rainfall can overwhelm rivers and trigger rapid flooding.[78] At the same time, higher temperatures lead to lower rainfall and increased heat in other parts of the world, heightening the risk of droughts and wildfires.[79] A community's level of exposure to a weather disaster is related to that community's approach to managing its own habitats. For example, many fires are caused by human activity, often in the pursuit of livelihoods (farming and otherwise) and according to age-old practices.[80]

RECENT TRENDS IN ENVIRONMENTAL DISASTERS

Number of natural disasters registered in EMDAT 1900-2005



Source: ISDR/CRED (2010)

Cyclones have often been considered a hallmark characteristic of climate change. It is easy to understand that logic – warming seas and air cause more water to evaporate, sending more moisture and energy into the air, which then fuels strong rains and winds. The idea that cyclone activity is increasing as a result of climate change is actually one of the most contested areas of climate science.[81] Still, there is evidence to support the assertion. In 2007, the world's leading scientific body in this field, the IPCC, concluded that climate change was causing an increase in tropical cyclone activity in the North Atlantic, although it cited only limited evidence for other regions.[82] And at the same time, worldwide data collected by reinsurance company Munich Re showed a 30% rise in the number of flood and storm insurance loss events over the last 30 years.[83]

FLOODS

Increased flooding is mainly attributed to localized rainfall, often in the context of storms. But flooding also results from accelerated glacial- and ice-melt from alpine or Arctic-fed rivers.[84] Storms and floods can cause significant casualties and destruction to affected communities. Drownings, physical injuries, and disease are all part of the human toll of such events. Complex emergencies can emerge within days of a major weather disaster, crippling communities that are not equipped to handle them.[85]

For communities forced to evacuate disaster zones, the impacts of such weather events may be especially severe and long-term. Storms and floods displace several million people every year by destroying homes and infrastructure.[86] Recent weather disasters have displaced millions of people in Myanmar, Mozambique, and Pakistan.[87] The most severe weather can cause catastrophic damage to infrastructure – roads, bridges communication lines, commercial premises, houses, and other buildings. It can also damage land and agricultural assets, in particular by destroying crops, decimating livestock, and contaminating soils with salt. Spring floods and autumn cyclones can be particularly damaging if they immediately precede or coincide with calving or harvest time.

The human toll is worst in the poorest and least resilient communities. Developing countries experience more than 90 percent of the fatalities caused by weather disasters. It's important to note that damage to infrastructure and other assets in poorer countries can be completely debilitating due to a lack of insurance coverage. Samoa lost 37% of its GDP to one cyclone.[88]

DEVELOPING COUNTRIES EXPERIENCE MORE THAN 90 PERCENT OF THE FATALITIES CAUSED BY WEATHER DISASTERS

WILDFIRES

Wildfires exact much less of a human toll. Their economic toll, however, while less than 3% of the total impacts of weather-related disasters, can have long-lasting effects. When fires approach populated areas, the impact can be devastating. Recent major fires in Australia, Greece, Spain, and Russia have caused significant casualties and damage.[89]

We cannot, with any confidence, blame any single storm, flood, or wildfire solely on climate change. But there is a plausible link between these events and what has been predicted by a number of climate change scenarios. Even if natural weather events are aggravated by climate change to a degree of only 5 or 10 percent, on a global scale that added stress could be immense. Like the straw that broke the camel's back, the added pressure of more frequent or higher intensity weather can make all the difference between a community that copes and a community in disaster. Given that highly effective measures exist to reduce disaster risk, policy makers have every reason to prepare for these new scenarios.

The number of documented fatalities from weather disasters surged in the 1990s (a rise that was at least partly due to improved reporting of casualties) but has fallen again since the start of the new millennium.[90] If Cyclone Nargis is removed from the 2000-2009 data, the last decade accounts for fewer than 100,000 such deaths. The drop in fatalities is mainly linked to improvements in disaster risk reduction introduced over this period. This means that fatalities are no longer a good stand-alone indicator of damage suffered by communities around the world. Hence this report also uses damage costs as a means of measuring impacts. Still, climate change does stress even good disaster reduction measures with its added risks.

Statistics covering weather-related economic damages are quite limited, so we have no universally useful record of damage costs

EVEN IF NATURAL WEATHER EVENTS ARE AGGRAVATED BY CLIMATE CHANGE TO A DEGREE OF ONLY 5 OR 10 PERCENT, ON A GLOBAL SCALE THAT ADDED STRESS COULD BE IMMENSE

due to weather disasters. Economic data is only gathered above a certain threshold. Because it is heavily based on insured losses, it does not accurately quantify the losses inflicted on the poorest communities, which rarely have insurance coverage. But there are also instances in which communities have exaggerated their losses in an effort to secure more external support.[91] For this reason, the Climate Vulnerability Monitor gives this data much less weight than fatalities when determining a country's vulnerability level. Fatality data is generally considered more sound. We urgently need a more effective method for estimating the possible economic losses that can have a significant effect on vulnerable communities – one based on case study examples, for instance.

LINKS FROM CLIMATE CHANGE TO IMPACT INDICATORS

CLIMATE CHANGE EFFECTS	PHYSICAL CHANGES	VULNERABILITIES	IMPACT INDICATORS
• Changes in local rainfall and river run-off patterns • Rising sea levels • [Melting glaciers]	• Inland floods • Coastal floods	• Injuries • Access to clean water and food • Destruction of shelters and infrastructure	Impact of floods • Described as climate change impact on the number of deaths as share of population and as damage costs as share of GDP
• Rising surface temperatures	• Frequency and intensity of storms • Frequency and intensity of cyclones • Storm surges	• Injuries • Access to clean water and food • Destruction of shelters and infrastructure	Impact of storms • Described as deaths due to storms and as damage costs as share of GDP
• Rising temperatures • Changes in local rainfall	• Wildfires • Drought • Wind	• Injuries • Displacement • Destruction of property	Impact of vector-borne diseases • Described as deaths related to malaria and dengue due to climate change

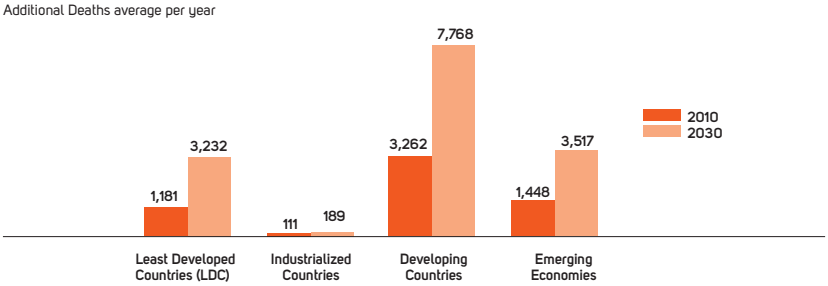
WHO SUFFERS?

Communities in the tropical and extra tropical regions are by far the most exposed to weather disasters. The worst-affected regions are the Caribbean, Central America, South America, South Asia, and Southeast Asia. The Pacific region suffers the highest damage costs.

THE SPREAD OF IMPACT: MORTALITY

The distribution of climate-related weather disaster mortality by socio-economic group in 2010 and 2030

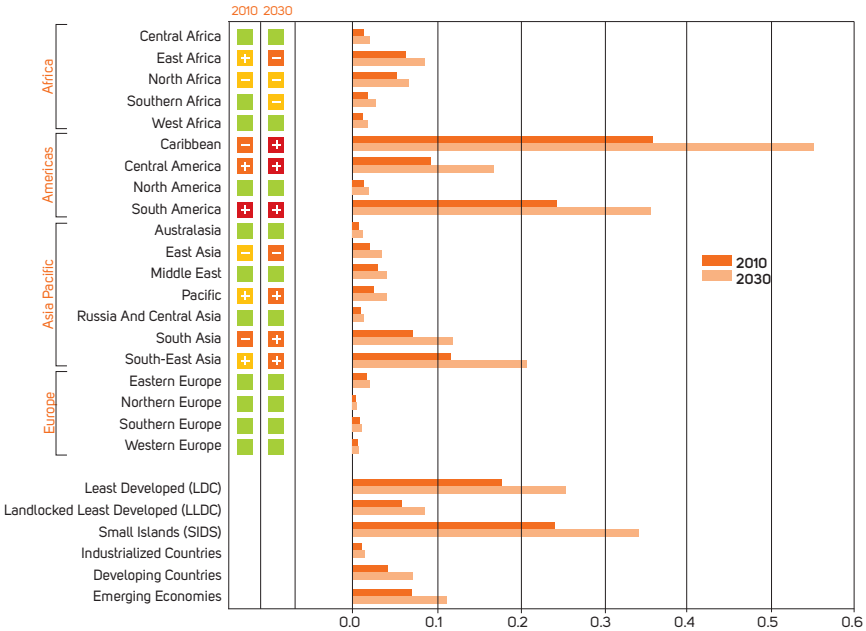
Additional Deaths average per year



A number of countries outside of the most-affected regions that have very low resilience also experience significant effects, including Somalia, Djibouti, and Afghanistan. Bangladesh is an example of a country severely affected by weather disasters that already has significant risk reduction measures in place that are likely preventing the worst effects.

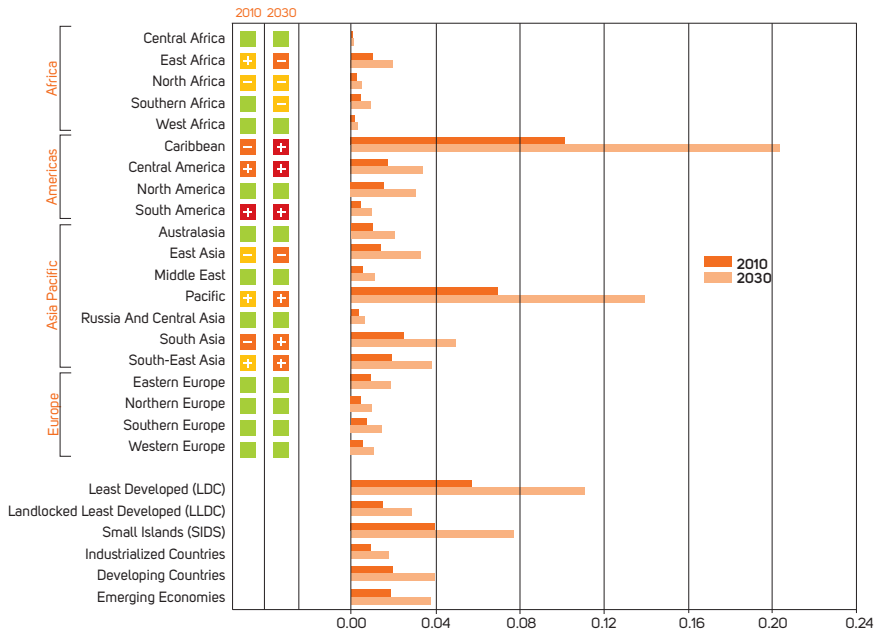
IMPACTS AROUND THE WORLD: MORTALITY

The regional and socio-economic distribution of additional deaths from extreme weather relative to population in 2010 and 2030
Deaths per 100,000, average per year



IMPACTS AROUND THE WORLD: DAMAGE COSTS

The regional and socio-economic distribution of climate-related damage relative to GDP in 2010 and 2030
Additional damage cost (percent of GDP)



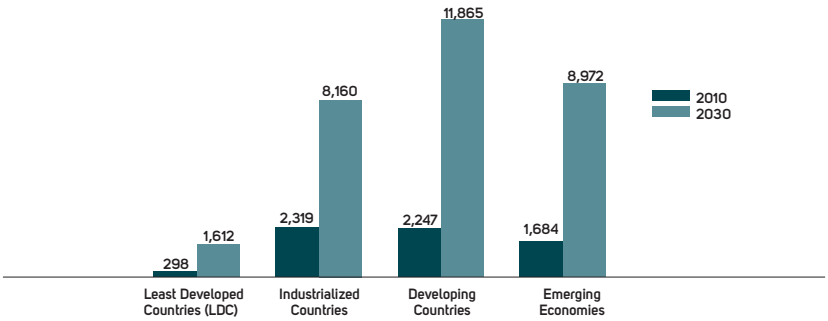
Venezuela tops the list of the worst-impacted countries. Venezuela has faced debilitating disasters over the past 20 years. However, it's possible that observations reported in the database used for the Monitor may exaggerate 1999 flood impacts in Venezuela by an order of magnitude.[92]

The projected excess deaths from weather disasters due to climate change are very concentrated among a small group of countries that are most acutely affected. Roughly 10 countries are projected to bear more than half the global deaths. The largest damage costs in absolute terms generally apply to the world's largest economies, with China and the United States projected to incur more than half the additional global damage due to climate change. But other countries, including Bangladesh and Iran, also face significant burdens.

THE SPREAD OF IMPACT: DAMAGE COSTS

The distribution of climate-related weather disaster damage cost by socio-economic group in 2010 and 2030

Additional damage cost (million USD PPP) average per year



Weather disaster impacts over the past 20 years provide us with key information for calculating these projections. They can point to trends in exposure to hazards and underlying vulnerabilities.

The Monitor gauges the impact of weather events in reference to the past number of reported fatalities a country has experienced. Another method of gauging impact is to look at the country's exposure to an event rather than at past damage. The 2009 Global Assessment Report on Disaster Risk Reduction, for example, used this approach to highlight all countries in the path of a disaster as exposed, whether or not high levels of fatality or damage had occurred. But exposure to weather disasters doesn't always imply vulnerability, and some countries in the path of a disaster will experience significantly greater losses than others for a variety of reasons.

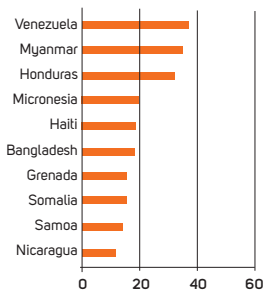
Although neither is the past necessarily the best indication of what is to come. But the Monitor, for example, does not highlight Cambodia, Vietnam, Philippines, and Fiji as highly vulnerable despite the fact that they lie in clear cyclone paths, since they have not registered high fatalities or damages during recent floods and storms -- which in itself is taken as indication that vulnerability is actually low in spite of high exposure. In a way, these countries may represent examples of good practice in disaster risk reduction, since each is in the clear path of danger but remains relatively untouched compared to other, similarly exposed countries.

It will be important to supplement the Monitor with methodologies that provide information about national-scale hotspots and hot weather systems and that can offer guidance to policy makers at the local level.

HIGH SURGE VULNERABILITY

Countries with the fastest growing climate-related weather disaster impact between 2010 and 2030

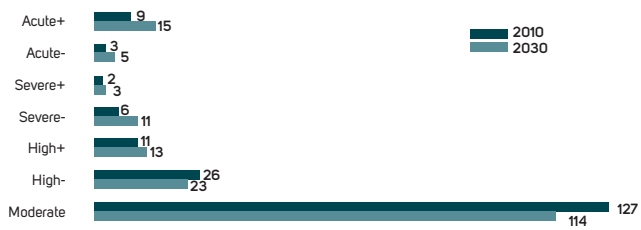
Percentage increase in climate-related weather disasters



VULNERABILITY SHIFT

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

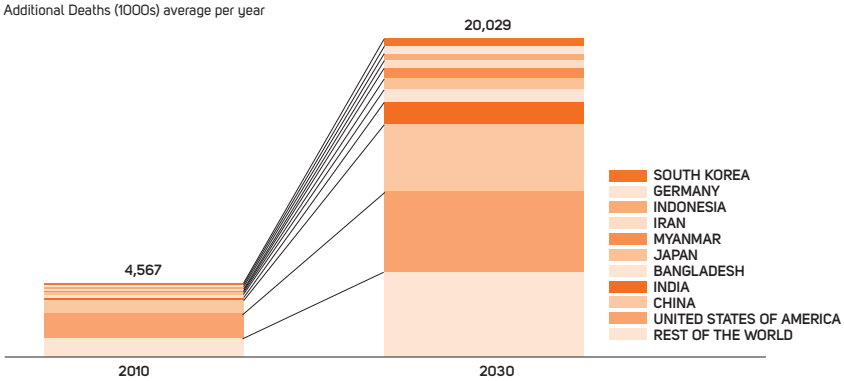
Number of Countries by Vulnerability Factor



HOTSPOTS: DAMAGE COSTS

Countries with the largest total climate-related weather disaster by damage cost

Additional Deaths (1000s) average per year



THE IMPACT TOMORROW: 2030

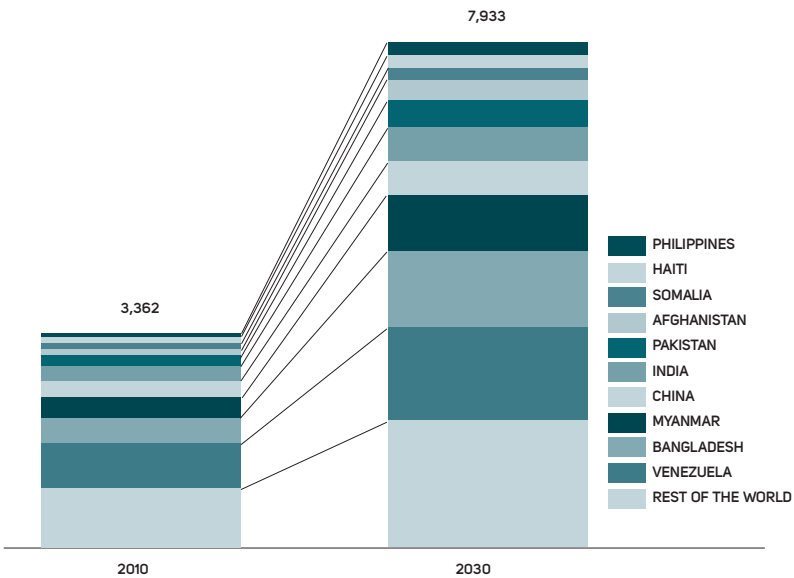
The Monitor projects that a relatively small number of countries will continue to suffer from the worst effects of weather disasters. Some 30 countries are projected to have severe or acute vulnerability factors by 2030.

Most of the worst-affected countries are also the countries where impacts are projected to rise the fastest between 2010 and 2030. However, Samoa and Nicaragua (currently not among the worst-affected) are examples of countries that are also projected to face significant increases in impacts.

HOTSPOTS: MORTALITY

Countries with the largest total climate-related weather disasters by number of deaths

Additional Deaths average per year



WORST HIT AND LEAST HIT (2030)

The top 10 countries worst and least affected by weather disasters related to climate change in 2030 relative to their size

WORST	LEAST
VENEZUELA	MARSHALL ISLANDS
HONDURAS	TUVALU
MYANMAR	SINGAPORE
HAITI	GABON
MICRONESIA	EQUATORIAL GUINEA
SOMALIA	BRUNEI
DJIBOUTI	PALAU
BANGLADESH	QATAR
GRENADA	SAO TOME AND PRINCIPE
AFGHANISTAN	KIRIBATI

SPOTLIGHT: SOUTH ASIA/STORM SURGE

The heaviest toll of weather disasters is extremely concentrated. Of the 1 million deaths due to floods, storms, and wildfires over the last 40 years, over 800,000 – or 80 percent – have occurred in just four countries, all of them in Asia: Bangladesh, China, India, and Myanmar. Half a million of those deaths have occurred in just one country: Bangladesh. Virtually all of the deaths that occurred in the next most affected country, Myanmar, occurred in the space of 24 hours when the country was struck by Cyclone Nargis in May 2008.[93]

Prior to 1960, China regularly experienced colossal weather disasters that claimed hundreds of thousands, even millions, of lives according to records.[94] In 1931, over 3 million people were killed in flooding, and over 2 million were killed in 1959. Since that date, China has lost a little more than 1,000 lives on average every year from these types of disasters, which for a country of over 1 billion people is extremely low. Hydroelectric power damns now prevent mass flooding of the country's main rivers, and modern disaster reduction practices have greatly limited fatalities due to typhoons. However, the recent Sichuan earthquake disaster has revealed a serious issue of construction integrity within China that predisposes much of the country to disasters of all kinds, including weather-related.[95]

Nearly all of the three quarter of a million deaths caused in the other three worst-affected countries over the last 40 years are attributable to just seven storms. The worst-affected areas of Bangladesh, India, and Myanmar also share five key characteristics: location in the tropics; extreme poverty; dense population; river deltas; and very low-lying land.[96]

The deadliest instrument of a cyclone is its storm surge, which is a swelling of the sea when storm winds helped by violent currents force water up against the shore.[97] When such a surge occurs at a riverhead, it meets with flooded waterways seething from massive amounts of cyclone-driven rain. Storm surge can reach over 5 metres or 18 feet in height and can rapidly engulf hundreds of kilometres of low-lying land. It is the cause of the lion's share of cyclone fatalities not only in Bangladesh, India, and Myanmar, but worldwide.[98]

The 2008 category 4 Cyclone Nargis that devastated Myanmar was an unexpected event, since the region has experienced a very limited number of storms of such scale in the past. No proper disaster alerts were issued to a population literally washed away without any advance warning.[99]

In India and Bangladesh, risk reduction has massively reduced fatalities due to these types of hazards over time. The category 3 Cyclone Bohla killed 300,000 people in Bangladesh in 1970 and still ranks as the deadliest single storm of all time. A more severe category 5 storm struck the same region in 1991 killing 140,000. By 2007, category 5 storms, such as Cyclone Sidr would claim just 4,000 lives. In the intervening period, the population of the country had more than doubled.[100]

The comparative impact of category 4 or 5 storms in neighbouring countries within half a year of each other is a clear testament to the effectiveness of contemporary risk reduction measures: Bangladesh (Sidr: 4,000 deaths) had such measures in place. Myanmar (Nargis: 130,000) did not.[101]

But all disaster risk reduction need not be artificially imposed. After experiencing the trauma of a large-scale disaster, communities may automatically adopt more cautionary practices. Still, the damage associated with storm surges can often only be avoided with extended advance warning, since massive swaths of populated coastal territory must be evacuated to higher ground. Without adequate monitoring and communication channels, no level of local practice could assist a population under imminent threat of a category 4 or 5 cyclone storm surge.

TROPICAL CYCLONE STRENGTH "SAFFIR–SIMPSON HURRICANE SCALE"

CATEGORY	**WIND SPEED** mph (km/h)	**STORM SURGE** ft (m)
FIVE	≥ 156 (≥ 250)	> 18 (> 5.5)
FOUR	131–155 (210–249)	13–18 (4.0–5.5)
THREE	111–130 (178–209)	9–12 (2.7–3.7)
TWO	96–110 (154–177)	6–8 (1.8–2.4)
ONE	74–95 (119–153)	4–5 (1.2–1.5)

Source: US National Hurricane Center

While early warning systems, such as emergency alerts, evacuation plans, crisis shelters, and other measures can save lives, it is much harder to prevent damage to infrastructure and land.[102] So while by the time of Cyclone Sidr Bangladesh had reduced the death toll by a factor of 35 compared with the 1991 cyclone, the economic damage of each was comparable at roughly USD 2 billion.[103] And similar swaths of arable land were once more contaminated with salt, destroying productive capacity in a land of much subsistence farming.

THE ASSESSMENT

The Monitor assesses vulnerability to weather disasters by applying climate change risk factors for floods developed by the WHO, and storms and wildfires to historical (1990-2009) national statistics of mortality (80% weighting) and relative damage costs (20% weighting). The climate risk factor for floods is higher than for storms or wildfires, reflecting a stronger scientific link between climate change and heavy rainfall and other flooding triggers.[104] The low weighting for damage costs reflects the lower quality and coverage of the base information.

The number of people affected or in need of aid as a result of disasters is not included as an indicator, because each country and extreme event is likely to come up with a different definition of "affected". Only those countries with a historical record of deaths and damage from floods, storms, and wildfires will register as vulnerable to any degree. Countries with higher registered impacts to such phenomena over the last 20 years will register higher factors of vulnerability, as past impact is deemed an accurate indicator of future impact, capturing both exposure to floods, storms, and wildfires, and the level of protection or underlying vulnerabilities. Mortality is assessed relative to total population, and damage costs are assessed relative to total GDP, so that vulnerability factors take into account the relative burden of impacts within a given country.

The methodology for assessing vulnerability to extreme weather is less robust than for the Health Impact section of the Monitor. This is mainly because the reporting quality of economic damage is poor across the board. But also because mortality in extreme weather has been significantly reduced in modern times and is therefore no longer the best indicator of generalized vulnerability. However, those most vulnerable to weather disasters still register high levels of mortality, and so the Monitor is accurate in identifying these highly vulnerable countries. The few countries with factors of Acute or Severe have all experienced significant loss of life as a result of extreme weather in recent years. Yet since mortality profiles are quite similar and low across the board, many countries register similar factors of vulnerability. Countries with significant economic damages as a result of floods, storms, and wildfires, however, will also have their higher vulnerability recognized by the Monitor despite having low levels of mortality in many cases.

Mexico (Moderate/Moderate) stands out in particular as a country whose vulnerability appears to be underestimated. On closer inspection, though, Mexico is a large country with a demonstrated ability to minimize loss of human life even in the most severe weather conditions. Mexico is located in the main tropical cyclone pathway of the southern Caribbean and has suffered dozens of devastating hurricanes in recent history. In 2005, the category 1 Hurricane Stan affected some 2 million people, killing 36, with unprecedented torrential rain that caused USD 2.5 billion in damage. A few weeks later, category 5 Hurricane Wilma, the most intense cyclone ever recorded in the Atlantic, affected 1 million people and claimed USD 5 billion in damage but only 7 lives. Over the last 10 years, 29 major tropical cyclones have claimed just 174 lives out of a total population of over 110 million people. The billions of dollars in damage caused is only a fraction of a trillion-dollar-a-year economy.[105] Mexico is a good example of how communities under heavy environmental and climate stresses can minimize impacts, in particular the loss of human life, even when millions of people are affected. While the damage to infrastructure caused by extreme weather is still high, financial risks can be covered through insurance, enabling affected communities to bounce back quickly from severe storms and flooding.

The United States (Moderate/Moderate) is another country with surprisingly low vulnerability to extreme weather in the Monitor. As with Mexico, this is mainly due to the sheer size of the country and its economy. But, again, it is also due to the minimal human casualties caused by major storms, which is the main base measure for the Monitor. The US has three times the population of Mexico and ten times its economy, so even the most expensive tropical storm in history (Hurricane Katrina caused USD 125 billion in damage) and the deadliest of recent US history (with over 1800 deaths) is simply dwarfed by the country's sheer size. Many of the most serious storms that have affected the US in recent years, such as hurricanes Charley, Dennis, Ida, Jeanne, and Rita have all claimed less than 10 lives each. Exceptionally deadly hurricanes by US standards, such as Allison (41 casualties), Ike (82), Ivan (52), Frances (47), and Gustav (43), are nevertheless significantly less deadly than weather disasters occurring in acutely vulnerable countries such as Bangladesh or Myanmar, which have claimed tens of thousands of lives.[106]

A series of small island states residing in known cyclone paths also find themselves with relatively low vulnerability factors of Moderate/Moderate; they include Barbados, French Polynesia, Kiribati, Marshall Islands, Mauritius, New Caledonia, Saint Lucia, Trinidad and Tobago, and Tuvalu. But all these countries combined have registered only 29 deaths from all storms and floods since 1990, demonstrating low vulnerability to loss of life from extreme weather. Mauritius aside, all combined recorded storms and floods over that time cost the other eight countries just USD 125 million (or about USD 700,000 per country, per year if averaged). Mauritius lost around USD 150 million in each of two major storms in the 1990s, but this was less than 2% of a USD 8 billion economy. Antigua and Barbuda (High-/Severe+), on the other hand, lost USD 400 million to Hurricane Luis in 1995, or almost two thirds of its annual GDP at the time.[107]

Venezuela (Acute+/Acute+) received the highest factor of vulnerability because the Vargas flood disaster of 1999 is recorded to have claimed 30,000 lives in a country of some 25 million people. However, a recent study has revealed that the reported death toll was inaccurate and that the actual death toll was likely not more than 700, which would result in a much lower factor of vulnerability for Venezuela. Since the Monitor's climate risk factor for floods is higher than for storms or wildfires, the Venezuelan Vargas flood anomaly has had a greater impact on its overall vulnerability factor. The example illustrates that the Monitor is highly dependent on historical data and relies on key data that varies widely in terms of quality.[108]