STORMS

ESTIMATES GLOBAL CLIMATE IMPACT

2010 EFFECT TODAY

DEATHS PER YEAR **2,500**

USD **LOSS** PER YEAR **15 BILLION**

2030 EFFECT TOMORROW

DEATHS PER YEAR **3,500**

USD **LOSS** PER YEAR **100 BILLION**

CONFIDENCE **SPECULATIVE**

SEVERITY

AFFECTED

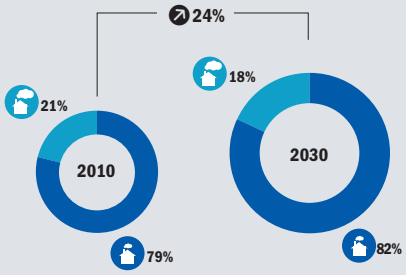
INJUSTICE

PRIORITY

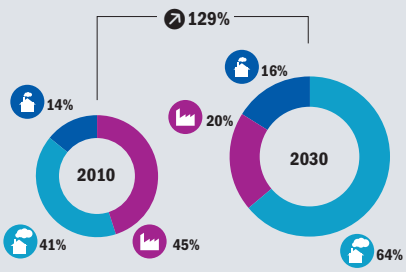
MDG EFFECT

- All weather is affected by climate change because the Earth's atmosphere is warmer, moister, and more active today than in the recent past
- As a result, storms are becoming more extreme both in and outside of the tropics and will cause greater damage
- The location and extent of the additional damage is difficult to predict, as experts and their studies differ in their conclusions
- Countries already exposed to tropical cyclones or immediately adjacent to cyclone belts should prepare for growing risks and damages, especially in coastal areas

MORTALITY IMPACT



ECONOMIC IMPACT



RELATIVE IMPACT

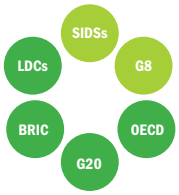
82 2010

93 1 2030

$$$$ 27 2 2010

$$$$$$$ 58 2 2030

GEOPOLITICAL VULNERABILITY



HOTSPOTS

2010 2030

1,750 **BANGLADESH** 2,500

500 **MYANMAR** 600

150 **INDIA** 150

50 **MADAGASCAR** 100

45 **PHILIPPINES** 60

2010 $ 2030

4,750 **CHINA** 50,000

4,000 **JAPAN** 10,000

2,500 **UNITED STATES** 8,250

550 **NORTH KOREA** 5,750

600 **SOUTH KOREA** 4,750

Deaths | Economic Cost (2010 PPP non-discounted)

Developing Country Low Emitters | Developed

Developing Country High Emitters | Other Industrialized

= Deaths per 10 million

$ = Losses per 10,000 USD of GDP

Change in relation to overall global population and/or GDP

=Millions of USD (2010 PPP non-discounted)

Whether or not specific events can be identified as "caused" by climate change, all weather is now affected by a global climate system that is warmer, more active, and wetter (Trenberth, 2012). As a result, it is evident that storms are generally becoming more extreme, particularly in terms of wind speeds and quantity of rainfall. Moreover, there is a pole-ward shift to the north and south of cyclone storm tracks, as parts of the world adjacent to the tropics are experiencing more "tropical" weather. Where vulnerabilities to more severe storms are accentuated by environmental and income-related factors—such as for high-risk urban slums in low-lying coastal areas—the dangers of these changes are much higher (IPCC, 2012a). Corresponding measures will need to offset the additional risk by reducing community vulnerabilities and, where possible, limiting exposure, to storm hazards (UNISDR, 2009 and 2011). Increased emergency assistance should also be foreseen in the coming years and decades.

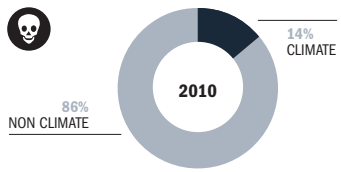
CLIMATE MECHANISM

Climate change increases air and sea temperatures, boosting the level of moisture in the atmosphere; this leads to acceleration of the planet's hydrological system, heavier precipitation, higher maximum winds and a general tendency to more extreme weather (IPCC, 2007). These hallmarks have been recognized in storms, including cyclones (IPCC, 2012a). Whether or not there has been a change in the frequency or overall number of cyclones in recent years can side-track the focus on other important factors, such as wind speed changes (Knutson et al. in Chan et al. (eds.), 2010). Simply counting the change in the number of cyclones often leads to the conclusion that there is less cyclone activity, since there is generally understood to be a slight increase in the most extreme cyclones, such as categories 3 to 5, but an overall decrease in the total number of cyclones since the reduction in less severe storms is expected to be greater (Knutson et al., 2010). It is not surprising that an increase in the most extreme cyclones, as measured on the well-known Saffir-Simpson scale results in fewer cyclones overall, since the scale itself is static, measures overall power, and is a rough proxy for the size of storms (Dolan and David, 1992; Irish et al., 2008). Larger more powerful storms absorb and dissipate considerably more energy than smaller ones, whose declining numbers have been attributed to an overall decline in cyclone frequency in recent times (IPCC, 2012a). Nor is the ultimate number of storms as important as the intensity or size of those storms: in the US, 85% of all cyclone damage is caused by the most extreme storms (Rudeva and Gulev, 2007; Pielke et al., 2008). A large share of the damage caused by cyclones is the result of storm surge, or inundations from rainfall, high winds, and freak waves caused by major storms, which have been worsened by heavier rainfall and sea-level rise, both of which are fuelled by climate change (Dasgupta et al., 2009).

IMPACTS

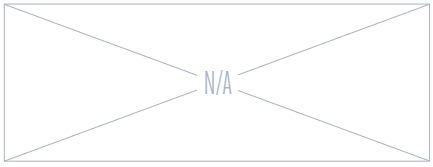
The impact of climate change on both tropical cyclones and major storms outside of the tropics (extra-tropical cyclones) is estimated to already cost 15 billion dollars and to be responsible for an average of almost 2,500 deaths each year, with around 1.5 million people affected and in need of emergency assistance.
In global terms, the number of countries experiencing extreme effects is limited, particularly since the great majority of losses relate to tropical cyclones, which are a serious concern for only 30 to 40 countries in the world's cyclone belts. A dozen countries in Asia, Africa, the Pacific, and the Caribbean are estimated to suffer Acute or Severe vulnerability to climate change-aggravated storm effects. The countries most vulnerable cut across the socio-economic spectrum from Japan to major emerging economies, such as China, least developed countries such as Madagascar, or small island developing states, such as Haiti.
Bangladesh is currently estimated to suffer the greatest human impact of these effects, with over 1,000 additional casualties due to climate change on an averaged yearly basis—major storms do not occur annually, but once in every 5 to 20 years. Myanmar and India are estimated to suffer the next greatest share of additional casualties. In overall economic terms, China, Japan, the US, North Korea, and South Korea experience the greatest estimated losses, incurring between 2 and 5 billion dollars a year in damages. A number of small island countries, such as Antigua and Barbuda, Dominica, Grenada, and Vanuatu are identified as experiencing the most severe economic and human loss

BIGGER PICTURE

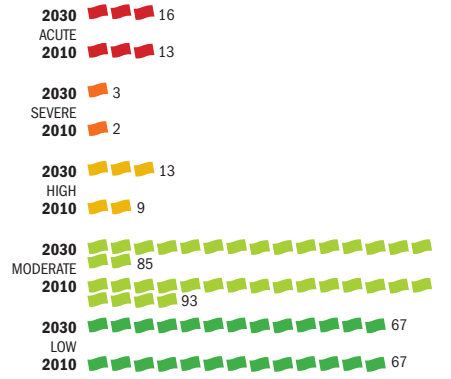


SURGE

OCCURRENCE



VULNERABILITY SHIFT



PEAK IMPACT

2008	MYANMAR 138,366	2005	UNITED STATES 158,230
2007	BANGLADESH 4,275	2004	JAPAN 15,144
2004	HAITI 2,757	2005	MEXICO 7,910
2005	UNITED STATES 1,882	2006	CHINA 7,859
2004	PHILIPPINES 1,861	2000	NORTH KOREA 6,000

GENDER BIAS

INDICATOR INFORMATION

MODEL: Donat et al, 2011; Mendelsohn et al., 2011

EMISSION SCENARIO: SRES A1B (IPCC, 2000)

BASE DATA: Tropical storms: Mendelsohn et al., 2011 (economic); Peduzzi et al., 2012 (mortality). Extra-tropical storms: CRED EM-DAT, 2012; Munich Re NATCAT, 2010 (economic)

$ = Millions of USD (historic)

Acute Severe High Moderate Low

= 5 countries (rounded)

relative to size. Several countries located on the Central American isthmus, such as Belize, El Salvador, and Honduras are exposed to tropical cyclones originating in both the Caribbean/Atlantic and Pacific Oceans, and are estimated to suffer extreme effects.

THE BROADER CONTEXT

As with other weather-related disasters, two key trends provide the context for the changes in extreme weather hazards which researchers increasingly attribute to climate change: 1) reductions in vulnerability due to continued economic growth especially in developing countries; and 2) an increase in the number of people and the amount of infrastructure exposed to extreme weather, due to the combined effects of population growth, urbanization, and economic development (UNISDR, 2011; Peduzzi et al., 2012). Correcting for these developments and other inconsistencies, evolution in reporting systems and biases in the statistical record have led to mixed interpretations of whether the scale of impacts due to climate change are increasing or decreasing (Mendelsohn et al., 2011; Pielke et al., 2008). The insurance industry has been registering greater and greater losses from weather-related catastrophes, including storms, over the past several years (Swiss Re, 2010, 2011, and 2012).

VULNERABILITIES AND WIDER OUTCOMES

Particularly noteworthy in terms of environmental vulnerabilities to storms are low-lying coastal communities which will bear the brunt of the increasing effects of climate change on heavy rainfall, wave height, and storm surge during cyclones (Füssel in Edenhofer et al. (eds.), 2012). Significantly altering the risk profile of countries are existing protection levels and capacities embodied in infrastructure, early warning systems, social and community response, support networks and levels of awareness about disasters. Likewise, government capacity to manage risks, as well as land use and environmental planning and protection can all affect the level of vulnerability, e.g., inappropriate urbanization or the clearing of coastal mangrove forests, which otherwise provide protection against winds and storm surges (UNISDR, 2009 and 2011; IPCC, 2012a). Migration patterns are fuelling rapid and inappropriate urbanization, leading to growing settlements in high-risk coastal flood zones, which themselves are seeing a depletion in natural protection, as from the destruction of mangrove forests (Donner and Rodriguez, 2008; Füssel in Edenhofer et al. (eds.), 2012). Where insurance coverage is low, the ability of affected communities to rebound from disasters is greatly inhibited (Dodman and Satterthwaite, 2008). This is especially a concern among developing and lower-income countries, such as small island developing states, where the scale of impact can also generate important setbacks for development (Pelling and Uitto, 2001).

RESPONSES

Numerous preventive measures can be taken to reduce key vulnerabilities and minimize naturally increasing exposures to disaster. Possible efforts include education and communication programmes, promotion of community volunteer emergency organizations, supporting governments to develop and implement action plans to manage risks through sensible municipal planning, constructing protective infrastructure, reinforcing environmental protection to limit risk-multiplication, and promoting access to insurance products. Better management of urbanization and urban-rural migration flows would also help lower risks for coastal mega-cities (de Sherbinin et al., 2007). Progress in human development and poverty reduction will inevitably enhance capacities to withstand serious storms and limit the damage to the highest risk groups, requiring integrated strategies regarding climate change, disaster risk, and development strategies (Schipper and Pelling, 2006).

THE INDICATOR

Although the increasing severity of weather including tropical and extra-tropical cyclones is well established, the indicator is considered speculative because there is considerable disagreement among the models predicting change in cyclone intensity for different regions of the world. With the exception of the North Atlantic, where evidence of an increase in extreme weather is strongest, predictions of changes in cyclone activity in the Indian and Pacific oceans differ widely (Mendelsohn et al., 2011; IPCC, 2012a).

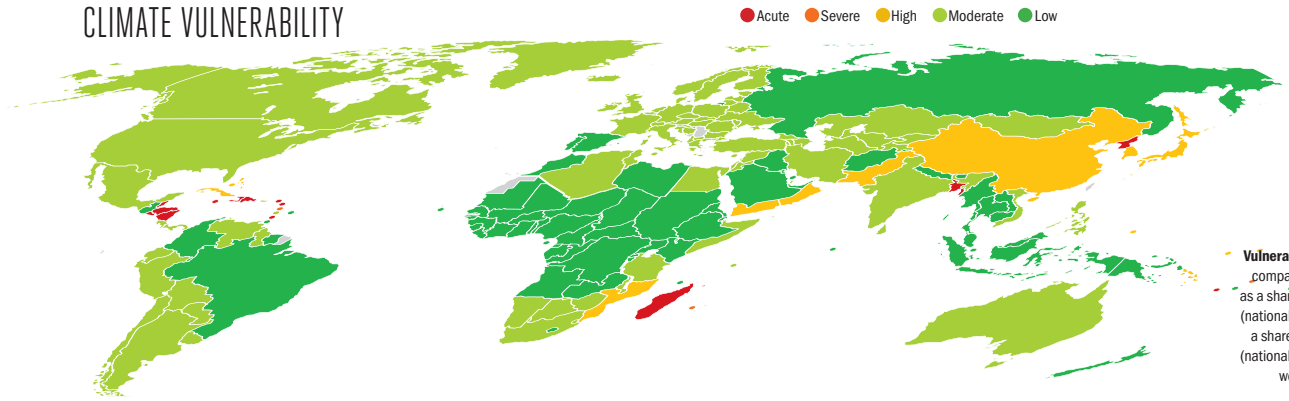
ESTIMATES COUNTRY-LEVEL IMPACT

COUNTRY	2010	2030	2010	2030	2010	2030
ACUTE						
Antigua and Barbuda			30	250	700	650
Bangladesh	1,750	2,500	150	1,250	400,000	600,000
Belize			30	250	550	700
Dominica			15	150	-90	-100
Dominican Republic	10	10	200	1,750	20,000	20,000
El Salvador			250	1,750	5	15
Grenada			25	200	-35	-60
Haiti	15	20	25	200	5,750	8,500
Honduras	1	1	200	1,500	200	350
Jamaica		1	100	800	1,000	2,500
Madagascar	50	100	40	250	150,000	300,000
Myanmar	500	600	1	20	10,000	15,000
Nicaragua	1	1	50	350	250	550
North Korea			550	5,750	2,250	-950
Tonga		1			-3,750	20,000
Vanuatu	5	10		-1	7,250	15,000
SEVERE						
Mauritius	1	1	25	150	500	400
Saint Lucia			1	20	15	10
Samoa		1		-1	750	5,750
HIGH						
Bahamas		1			400	450
China	1	-5	4,750	50,000	100,000	-250,000
Cuba	-1	-1	100	850	-75,000	-200,000
Japan	-10	-20	4,000	10,000	-10,000	-30,000
Marshall Islands					55	650
Micronesia					1	25
Mozambique	15	25	1	15	150,000	200,000
Oman			75	550		
Pakistan	5	5	250	2,250	4,500	8,750
Palau					200	450
Solomon Islands	1	1			8,500	20,000
South Korea		-1	600	4,750	-25	-200
Yemen			25	200		
MODERATE						
Albania						
Algeria				1		
Argentina			1	10		
Armenia						
Australia	1	1	-1	-1	100,000	150,000
Austria			5	10		1
Azerbaijan						
Belarus						
Belgium			1	10	1	1
Bolivia						
Bosnia and Herzegovina						
Botswana						
Bulgaria						
Canada			1	5		
Chile			1	10		
Costa Rica			1	10	950	1,250
Croatia						
Cyprus						
Czech Republic			1	5	550	1,000
Denmark			5	15	10	20
Djibouti						
Ecuador						
Egypt						
Estonia			1	1		
Finland				1		
France		1	40	95	3,250	6,000
Georgia				1		
Germany			100	350	25	50
Greece				1	5	
Guyana					1	
Hungary					1	
Iceland						
India	150	150	550	4,250	300,000	350,000
Iran			250	1,750		
Ireland				1	1	
Israel				1	10	
Italy				1	5	
Jordan					1	
Kazakhstan						
Kuwait				1	15	
Kyrgyzstan						
Latvia				1	10	400	750
Lebanon				1	5		
Lithuania					1	250	500
Luxembourg				1	1		
Macedonia							
Malawi					1		
Malta							
Mexico	10	15	150	1,250	70,000	85,000
Moldova				1	5		
Mongolia							
Namibia							
Netherlands				1	5	90	200
Norway				1	5		
Panama						25	30
Paraguay							
Peru				1	10		
Philippines	45	60	15	100	200,000	250,000
Poland				1	10	1	1
Qatar				1	10		

Additional mortality due to climate change - yearly average

Additional economic costs due to climate change (million USD PPP) - yearly average

CLIMATE VULNERABILITY



Vulnerability measure: comparative mortality as a share of population (national) and losses as a share of GDP in USD (national) with same full weighting to both

CLIMATE UNCERTAINTY

COUNTRY	2010	2030	2010	2030	2010	2030
Romania			1	1		
Saint Vincent			1	5	-150	-150
Seychelles				1		
Slovakia			1	5		
Slovenia			1	5		
Somalia				1		
South Africa			5	20		
Sri Lanka			5	35	2,500	60
Swaziland						
Sweden			5	10	10	15
Switzerland			5	15	65	100
Syria						
Tajikistan			1	15		
Tanzania			15	90		
Tunisia						
Turkey						
Turkmenistan						
Ukraine			1	5		
United Kingdom			20	60	55	150
United States	1	1	2,500	8,250	4,750	6,500
Uruguay				1		
Uzbekistan						
Venezuela				1		
Vietnam	10	10	-5	-75	15,000	15,000
Zimbabwe	1	5			6,500	15,000
LOW						
Afghanistan						
Angola						
Bahrain			-5	-35		
Barbados				1	-90	-250
Benin						
Bhutan						

COUNTRY	2010	2030	2010	2030	2010	2030
Brazil						
Brunei						
Burkina Faso						
Burundi						
Cambodia						
Cameroon						
Cape Verde						
Central African Republic						
Chad						
Colombia						
Comoros						
Congo						
Cote d'Ivoire						
DR Congo						
Equatorial Guinea						
Eritrea						
Ethiopia						
Fiji	1	-1	-10	-75	5,250	-2,000
Gabon						
Gambia						
Ghana						
Guatemala		1	-1	-10	150	250
Guinea						
Guinea-Bissau						
Indonesia			-50	-400		
Iraq						
Kenya				-1		
Kiribati						
Laos	1	1	-5	-35	5,750	8,750
Lesotho						
Liberia						
Libya						

COUNTRY	2010	2030	2010	2030	2010	2030
Malaysia			-1	-10		
Maldives				-1	5	15
Mali						
Mauritania						
Morocco						
Nepal						
New Zealand			-5	-15	150	150
Niger						
Nigeria						
Papua New Guinea						
Portugal						
Russia	-1	-5	1	10	-150	-300
Rwanda						
Sao Tome and Principe						
Saudi Arabia			-30	-250		
Senegal						
Sierra Leone						
Singapore						
Spain			-1	-10		
Sudan/South Sudan						
Suriname						
Thailand			-5	-35	750	650
Timor-Leste						
Togo			-1	-10		
Trinidad and Tobago		-1			-250	-1,250
Tuvalu						
Uganda						
United Arab Emirates			-10	-85		
Zambia						

Additional persons affected/in need of emergency assistance due to climate change - yearly average