DROUGHT

ESTIMATES GLOBAL CLIMATE IMPACT

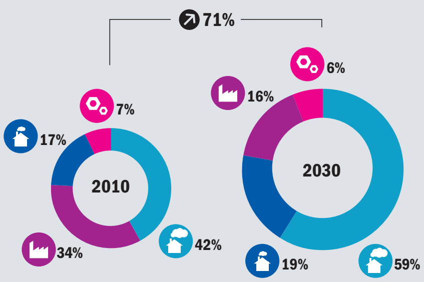
2010 EFFECT TODAY

USD LOSS PER YEAR **5 BILLION**

2030 EFFECT TOMORROW

USD LOSS PER YEAR **20 BILLION**

ECONOMIC IMPACT



CONFIDENCE
INDICATIVE

SEVERITY

AFFECTED

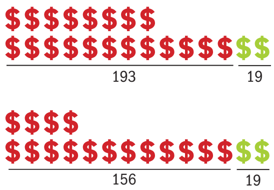
INJUSTICE

PRIORITY

MDG EFFECT

- As the planet's temperatures reach new highs drought will become more common and more severe
- Climate change also means more rain, but most of it is falling in the far north or far south where fewer people live, and much of this rain falls during the wet season while dry seasons tend to become drier
- When drought hits, agriculture comes under extreme pressure, crops may fail and livestock perish with important localized economic, health and social repercussions
- Catching and conserving water will be critical to ensure a resilient agricultural sector and food and water security during periods of extreme drought

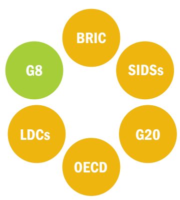
RELATIVE IMPACT



HOTSPOTS

2010	$	2030
800	CHINA	6,250
300	INDIA	1,500
200	IRAN	1,500
500	UNITED STATES	1,250
200	SPAIN	650

GEOPOLITICAL VULNERABILITY



Economic Cost (2010 PPP non-discounted)
Developing Country Low Emitters
Developed
Developing Country High Emitters
Other Industrialized

= Losses per million USD of GDP

Change in relation to overall global population and/or GDP

Millions of USD (2010 PPP non-discounted)

The increase in heat is already being experienced. It is virtually certain to increase in the coming years (IPCC, 2007). Parts of the world experiencing additional rainfall will also experience drought (Sheffield and Wood, 2008; Helm et al., 2010). Drought can diminish crop yields and kill livestock, generating serious economic losses for affected communities (Pandey et al. (eds.), 2007). Some of the world's major agriculturally productive regions, such as Brazil and Australia, are already affected (Saleska et al., 2011; LeBlanc et al., 2009). Deforestation and other forms of environmental degradation only worsen risk of drought (Turner II et al., 2007). Reducing losses and safeguarding communities will require the tackling of these problems as well stimulating increased water availability through effective capture, storage and distribution measures and policies (McKinsey & Company, 2009). Displacing risks to the insurance industry would also alleviate the severity of losses to individuals and communities (Linnerooth-Bayer and Mechler, 2006).

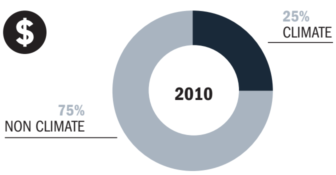
CLIMATE MECHANISM

A hotter planet not unsurprisingly implies more drought (Sheffield and Wood, 2008). This is qualified by the fact that because of climate change there will also be more moisture and rain in the atmosphere (Allen and Ingram, 2002; Huntington, 2006; Kharin et al., 2007). Additional rain however tends to fall far north or south, where it is not lacking, and less rain tends to fall in the tropical areas of the planet which are already near thermal maximums and where a majority of the world's population live (Helm et al., 2010; Sherwood and Huber, 2010). In parts of the tropics, clouds are gaining in altitude and failing to deposit their moisture on mountain ranges (Malhi et al., 2008). As evidenced in cities, even if more rain falls, provided heat rises faster, any additional water would evaporate and not benefit the soil and its vegetation (Schmidt in Hao et al. (eds.), 2009). Hence, global aridity has increased and is expected to continue increasing, including in areas like the US, which have largely escaped the most severe forms of drought to date (Dai, 2011). Even where rainfall is declining, it is becoming more concentrated generating longer dry spells (Trenberth, 2011). Moreover, country level analysis in Vietnam for instance shows how in regions prone to extreme heat rain will likely decline in dry seasons and only increase in wet seasons when there will be an overabundance (Vietnam MONRE, 2010). Extreme forms of heat experienced today, such as the European heat wave of 2003, the Russian heat wave of 2010, or the extreme summer temperatures of 2011 in Texas would have been extremely unlikely to occur in the absence of climate change (Hansen et al., 2012).
When drought hits, plant productivity is directly affected and the mortality risk for livestock, such as cattle or birds, is greatly raised and indirectly can create vulnerabilities which invasive pests can exploit, further increasing damage (Chaves et al., 2009; Lesnoff et al., 2012; Wolf, 2009; Cherwin, 2009). Economic losses clearly result (Pandey et al. (eds.) 2007; Ding et al., 2011). Drought also damages buildings and infrastructure due to the shrinking and swelling of soil under extreme heat and aridity. This can lead to structural failure or accelerate asset depreciation (Corti et al., 2009).

IMPACTS

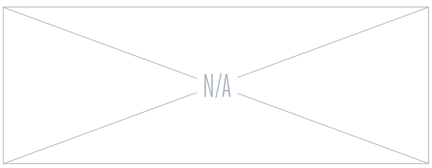
The global impact of climate change on drought is estimated to cause close to four billion dollars in damage a year in 2010, set to increase as a share of GDP to 2030 when average annual losses would reach close to 20 billion dollars a year. The impact is very widespread with some 160 countries experiencing high vulnerability to drought by 2030. There are many regions which are seriously affected, especially the wider Mediterranean basin and Black Sea, North Africa, the Middle East and southern and eastern Europe. In addition, parts of Central Asia and Southern Africa are also expected to experience severe effects. While mainly developing countries are affected, since developed nations in general are located geographically in the far north or south, a handful of major advanced economies are exposed to the most severe effects, in particular Spain, Portugal, Greece and Australia. Large numbers of least developed countries figure among those countries with Acute or Severe levels of vulnerability.
The largest total impact is felt in China whose estimated losses in 2010 of 800 million dollars would surpass six billion dollars a year in damage by 2030. Other countries with particularly large-scale impacts include India, Iran, the US, Spain, Mexico, Brazil and Russia – several are estimated to experience impacts in excess of 1 billion dollars in annual losses by 2030.

BIGGER PICTURE

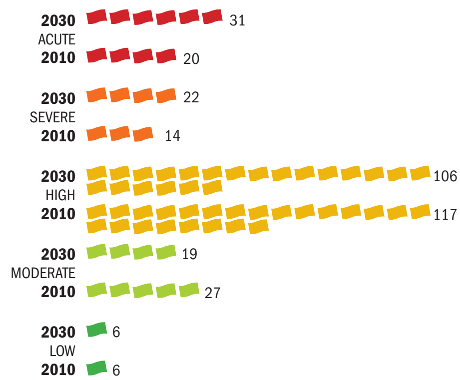


SURGE

OCCURRENCE



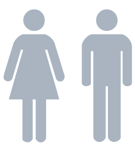
VULNERABILITY SHIFT



PEAK IMPACT

2002 MALAWI 500	2011 UNITED STATES 8,000
2006 CHINA 134	2009 CHINA 3,600
2005 BURUNDI 120	2002 AUSTRALIA 2,000
2004 KENYA 80	2004 BRAZIL 1,650
2002 UGANDA 79	2010 RUSSIA 1,400

GENDER BIAS



INDICATOR INFORMATION

MODEL: Corti et al., 2009; Hoekstra et al., 2010; Rubel and Kottek, 2010; Sheffield and Wood, 2007

EMISSION SCENARIO: SRES A1B (IPCC, 2007)

BASE DATA: Corti et al., 2009; CRED EM-DAT, 2012

$ = Millions of USD (historic)

= 5 countries (rounded)

Acute Severe High Moderate Low

THE BROADER CONTEXT

Virtually all of the costliest drought years have occurred in the last two decades (CRED/EM-DAT, 2012). For statistical reasons it is still difficult to conclusively discern and pronounce on any global trends in drought losses; however the IPCC and insurance industry have reported increases in drought impact, and regional drought has become extreme in recent years (Quarantelli, 2001; IPCC, 2007; Bouwer, 2011). Major agricultural zones of Australia have experienced prolonged drought for a decade, not attenuated by a return to pre-drought levels of rainfall as the heat rises (LeBlanc et al., 2009). A 2010 drought in Brazil and across the Amazon regions was one of the worst ever (Saleska et al., 2011). The insurance industry is gauging growing losses as a result of drought-triggered soil subsidence and damage to buildings and infrastructure, estimated to cost €340 million per year in France alone (Swiss Re, 2010).

VULNERABILITIES AND WIDER OUTCOMES

Geography is a prime vulnerability, since countries in the far north receive considerably more rainfall (IPCC, 2007; Helm et al., 2010). Demand for water is another key determinant of vulnerability, since drought in the middle of the Sahara is of little consequence, while drought in the southern US, Europe or India is a major concern. Global water demand is expected to almost double by 2030, in particular due to increased water withdrawals in the agricultural sector – just as climate change will deprive many of the world's productive regions of water (McKinsey & Company, 2009; Sheffield and Wood, 2008). Land degradation from over-intensive agricultural exploitation or over-grazing and deforestation also greatly increase susceptibility to drought – another 30 % loss of forest in the Amazon could push the entire region into permanent aridity (Malhi et al., 2008). A lack of adequate irrigation and water infrastructure exacerbates drought since water captured in other periods of the year cannot be drawn upon during periods of prolonged aridity. In general, water-deprived economies have been understood to be less prosperous (Brown and Lall, 2006). The human health consequences of drought are principally accounted for under the Hunger indicator of the Monitor.

RESPONSES

Any response to drought must face up to two key concerns: 1) increasing water availability, and 2) dealing with building and infrastructure damage due to sinking or destabilized land. Increasing water availability will be met at the market cost of supplying water, which varies from region to region depending on the degree of water scarcity currently prevailing locally (McKinsey & Company, 2009). Effective governments would anticipate any shortfall and stimulate action to meet any expected water demand shortfall in order to avoid economic losses and loss of tax revenues. Addressing soil subsidence through design could involve the retrofitting of buildings to withstand soil movements linked to drought. Both drought and soil subsidence impacts can be dealt with by displacing risks to the insurance (and micro-insurance) industry through policies enabling businesses and home-owners to safeguard against potential damages (Swiss Re, 2011; Churchill and Matul, 2012).

THE INDICATOR

The indicator measures the impact of climate change on drought, defined as a consecutive sequence of months with "anomalously low soil moisture". It measures the change in both disaster damages and depreciation of property due to soil subsidence damages. The change in the number of droughts expected to occur is estimated using an ensemble of eight climate models (Sheffield and Wood, 2008). Baseline data for disaster damages is derived from the main international disaster database, but is known to be incomplete (CRED/EM-DAT, 2012). Accelerated depreciation of infrastructure due to soil subsidence uses a model based on France and extrapolated based on GDP per capita and population density, but excluding arid countries where the effect is considered less relevant (Corti et al., 2009; Hoekstra et al., 2010). Limitations and uncertainties relate to difficulties in estimating rainfall change for certain regions, the simplistic 1:1 damage assumption implied and to the extrapolation used for the soil subsidence indicator.

ESTIMATES COUNTRY-LEVEL IMPACT

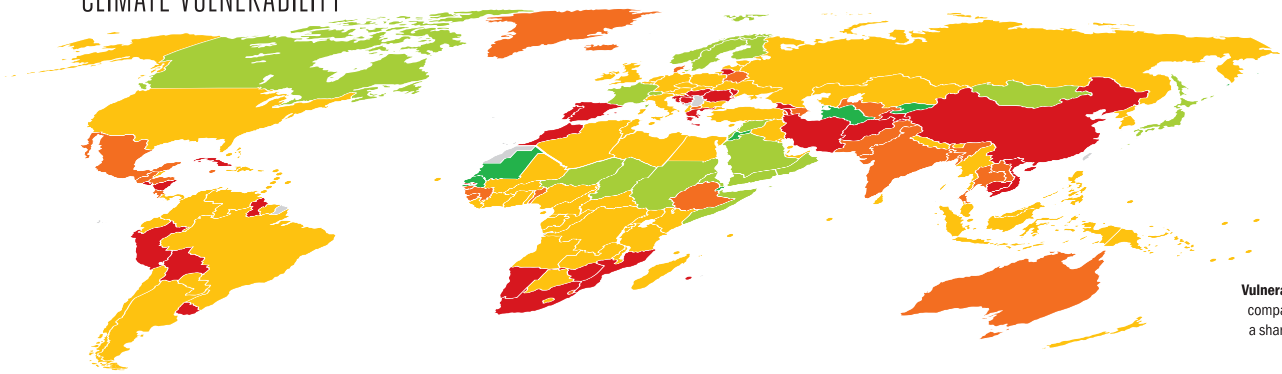
COUNTRY	$ 2010	$ 2030
ACUTE		
Afghanistan	5	40
Armenia	5	25
Bolivia	5	45
Bosnia and Herzegovina	15	100
Cambodia	5	60
China	800	6,250
Croatia	15	85
Cuba	10	65
El Salvador	10	70
Gambia		1
Georgia	10	50
Greece	35	95
Guyana	1	15
Hungary	15	90
Iran	200	1,500
Lithuania	10	45
Mauritius	5	25
Moldova	10	65
Morocco	40	300
Mozambique	1	10
Namibia	1	10
Nicaragua	1	15
Peru	25	150
Portugal	45	150
Romania	20	100
South Africa	50	250
Spain	200	650
Tajikistan	5	20
Uruguay	5	40
Vietnam	40	350
Zimbabwe	1	10

COUNTRY	$ 2010	$ 2030
SEVERE		
Australia	45	100
Azerbaijan	5	30
Bangladesh	15	75
Belarus	10	35
Benin	1	5
Costa Rica	1	15
Denmark	10	25
Ethiopia	5	20
Guatemala	5	20
Guinea	1	1
Guinea-Bissau		1
Honduras	1	10
India	300	1,500
Jamaica	1	5
Laos	1	5
Macedonia	1	5
Mexico	95	600
Pakistan	35	200
Sierra Leone		1
Swaziland		1
Thailand	40	200
Uzbekistan	5	30
HIGH		
Albania	1	5
Algeria	5	30
Angola	5	15
Antigua and Barbuda		
Argentina	25	150
Austria	10	10
Bahamas		1
Bahrain	1	5

COUNTRY	$ 2010	$ 2030
Barbados		1
Belgium	10	15
Belize		1
Bhutan		1
Botswana	1	5
Brazil	95	550
Brunei	1	5
Bulgaria	5	20
Burkina Faso	1	1
Burundi		1
Cameroon	1	5
Cape Verde		
Central African Republic		1
Chile	15	70
Colombia	15	80
Comoros		
Congo	1	1
Cote d'Ivoire	1	5
Cyprus	1	1
Czech Republic	10	40
Dominica		
Dominican Republic	5	20
DR Congo	1	5
Ecuador	5	30
Egypt	10	50
Equatorial Guinea	1	5
Estonia	1	5
Fiji		1
Gabon	1	5
Germany	70	100
Ghana	5	15
Grenada		

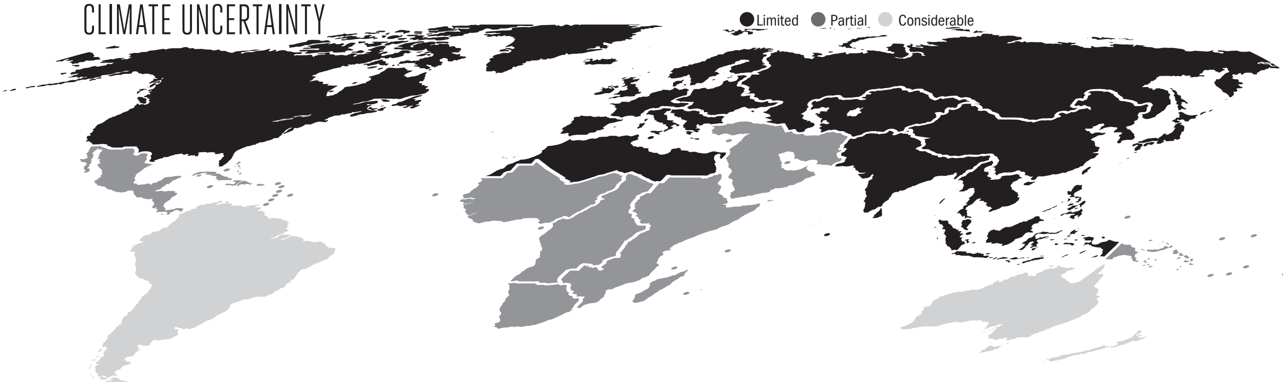
$ Additional economic costs due to climate change (million USD PPP) - yearly average

CLIMATE VULNERABILITY



Vulnerability measure: comparative losses as a share of GDP in USD (national)

CLIMATE UNCERTAINTY



COUNTRY	2010 ($)	2030 ($)
Haiti	1	1
Iceland		1
Indonesia	40	200
Iraq	5	15
Ireland	5	5
Italy	55	150
Kazakhstan	5	20
Kenya	1	5
Kiribati		
Kuwait	5	20
Latvia	1	5
Lebanon	1	10
Lesotho		1
Liberia		
Libya	1	10
Madagascar	1	5
Malawi	1	1
Malaysia	20	80
Maldives		
Mali	1	1
Malta		1
Marshall Islands		
Micronesia		
Myanmar	1	10
Nepal	1	10
Netherlands	15	25
New Zealand	5	5
Nigeria	15	70
North Korea	1	10
Palau		
Panama	1	10
Papua New Guinea	1	1

COUNTRY	2010 ($)	2030 ($)
Paraguay	1	5
Philippines	20	85
Poland	30	100
Qatar	5	20
Russia	90	400
Rwanda	1	1
Saint Lucia		1
Saint Vincent		
Samoa		
Sao Tome and Principe		
Seychelles		1
Singapore	10	40
Slovakia	5	15
Slovenia	1	10
Solomon Islands		
South Korea	55	250
Sri Lanka	5	25
Suriname		1
Tanzania	5	15
Timor-Leste		1
Togo		1
Tonga		
Trinidad and Tobago	1	5
Tunisia	5	15
Turkey	35	65
Tuvalu		
Uganda	1	10
Ukraine	20	75
United Arab Emirates	5	25
United Kingdom	55	90
United States	500	1,250
Vanuatu		

COUNTRY	2010 ($)	2030 ($)
Venezuela	10	45
Zambia	1	1
MODERATE		
Canada	25	45
Chad		
Eritrea		
Finland	1	1
France	45	75
Israel	1	15
Japan	90	150
Luxembourg	1	1
Mongolia		1
Niger		1
Norway	1	5
Oman	1	5
Saudi Arabia	1	10
Somalia		
Sudan/South Sudan	1	10
Sweden	5	10
Switzerland	5	10
Syria	1	5
Yemen	1	5
LOW		
Djibouti		
Jordan		
Kyrgyzstan		
Mauritania		
Senegal		
Turkmenistan		