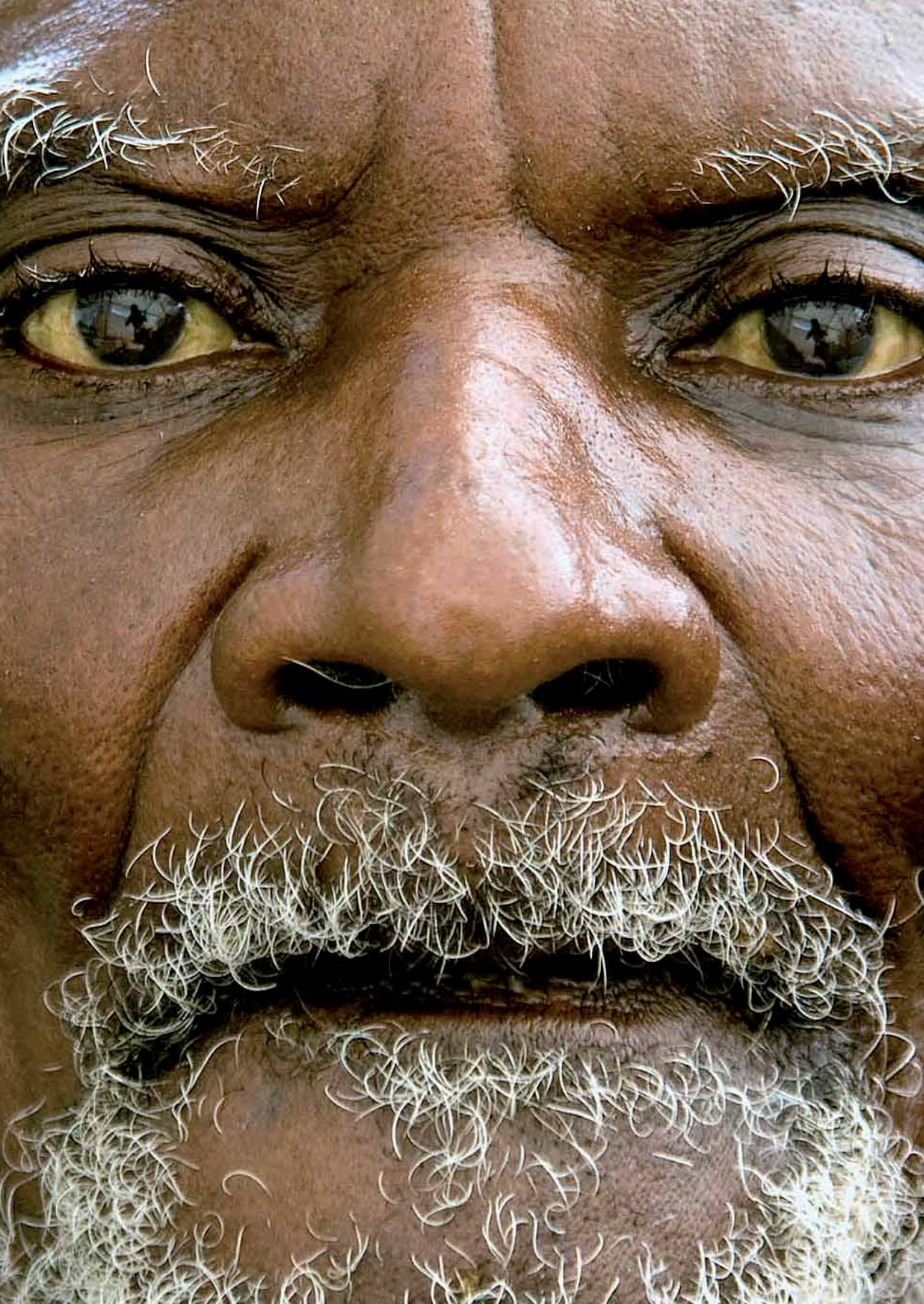
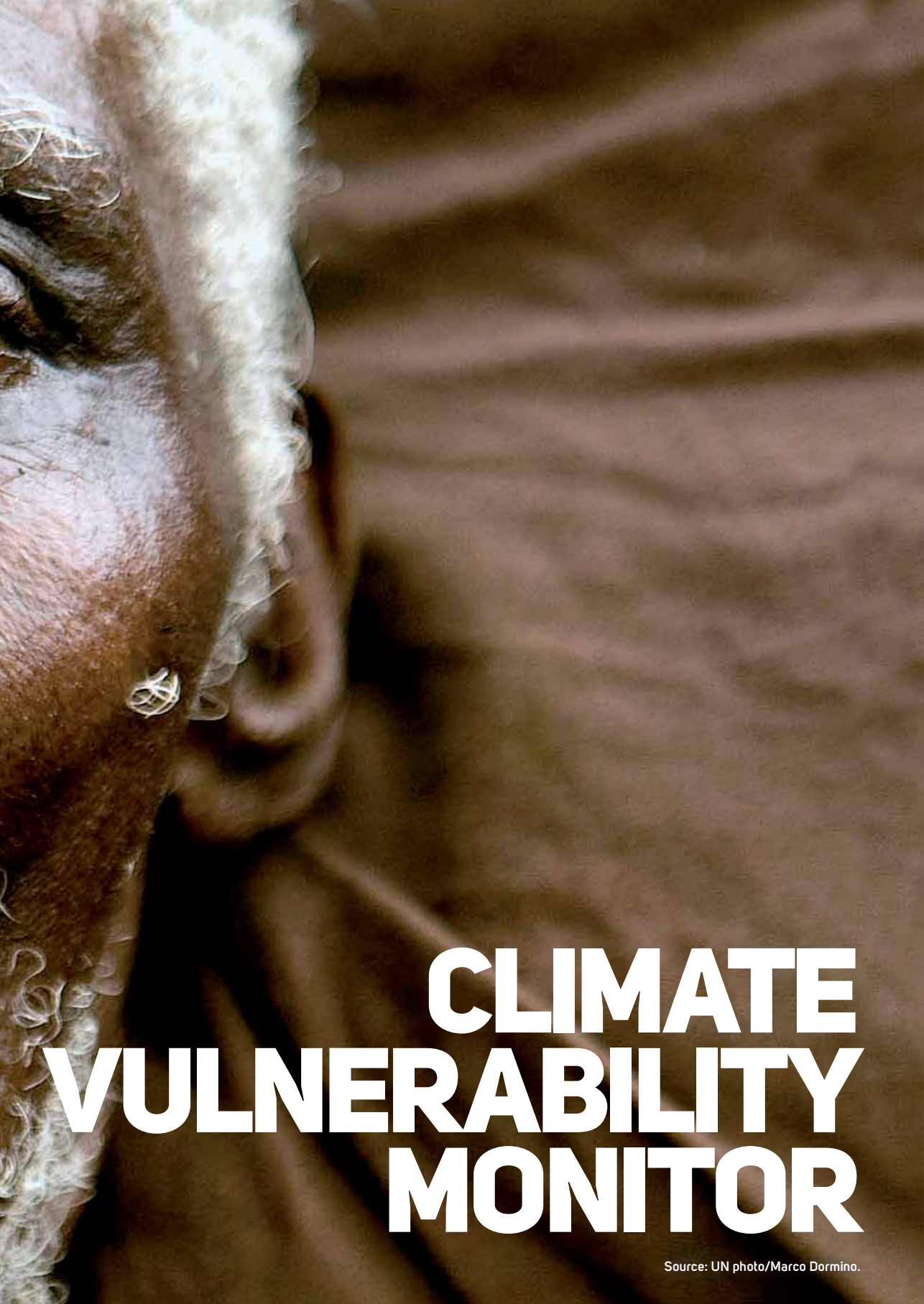




CLIMATE VULNERABILITY MONITOR

Source: UN photo/Marco Dormino.

THE CLIMATE VULNERABILITY MONITOR

The Climate Vulnerability Monitor provides a global overview of our vulnerability to climate change. It provides fair estimates of the types of impacts we are already facing due to changes in our climate. It shows where those impacts are taking place -- with most of the harm falling on already poor and vulnerable communities. The Monitor also captures our evolving vulnerability to climate change, which is on the rapid increase globally.

INTRODUCTION

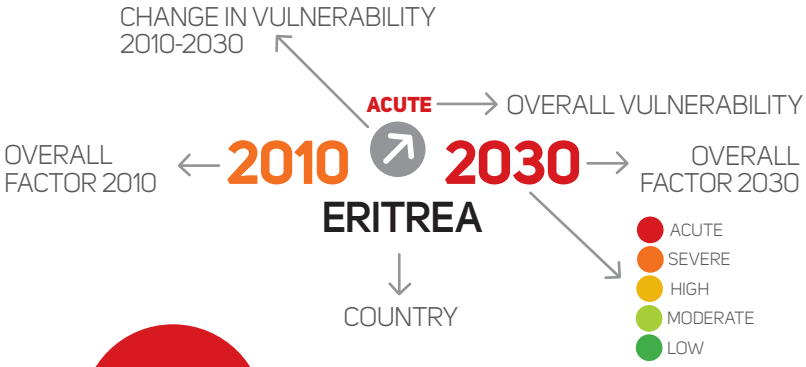
When monitoring estimated impacts of climate change on populations around the world it becomes immediately clear to what extent humanity is already in the depths of a fundamental and dangerous crisis. Most of the world's countries are already suffering negative impacts due to climate change in at least one or two different areas today. Only a few are experiencing any benefits. And these are far outweighed by the levels of damage and harm seen elsewhere. More than 50 countries will be acutely vulnerable to these effects by 2030 if measures are not taken to minimize the harm. Hundreds of thousands of lives are estimated to be lost with every year of inaction that goes by. The impacts are already so widespread that this challenge is endemic: A dozen regions register a factor of Acute vulnerability in at least one impact area.

It is possible to reduce vulnerability, of course. This report's Adaptation Performance Review outlines cost-effective measures for tackling all of the different types of impacts covered by the Monitor. For every factor increase in vulnerability there is also a corresponding drop in human development. The link between poverty and vulnerability to climate change could not be clearer. And a strategic reinforcement of human development strategies will also be critical in meeting this new challenge.

If we continue on the current path, in the next 20 years alone the number of most-vulnerable countries will double that of today. We can still take action to reverse this trend and stop the deadly and harmful impacts. If we do not act, vulnerability can only worsen. Fleeting benefits will vanish. And all nations will realize, one-by-one, an inevitable, global, vulnerability to a disrupted climate.

IF WE DO NOT ACT, VULNERABILITY CAN ONLY WORSEN. FLEETING BENEFITS WILL VANISH. AND ALL NATIONS WILL REALIZE, ONE-BY-ONE, AN INEVITABLE, GLOBAL, VULNERABILITY TO A DISRUPTED CLIMATE

GUIDE TO THE MONITOR



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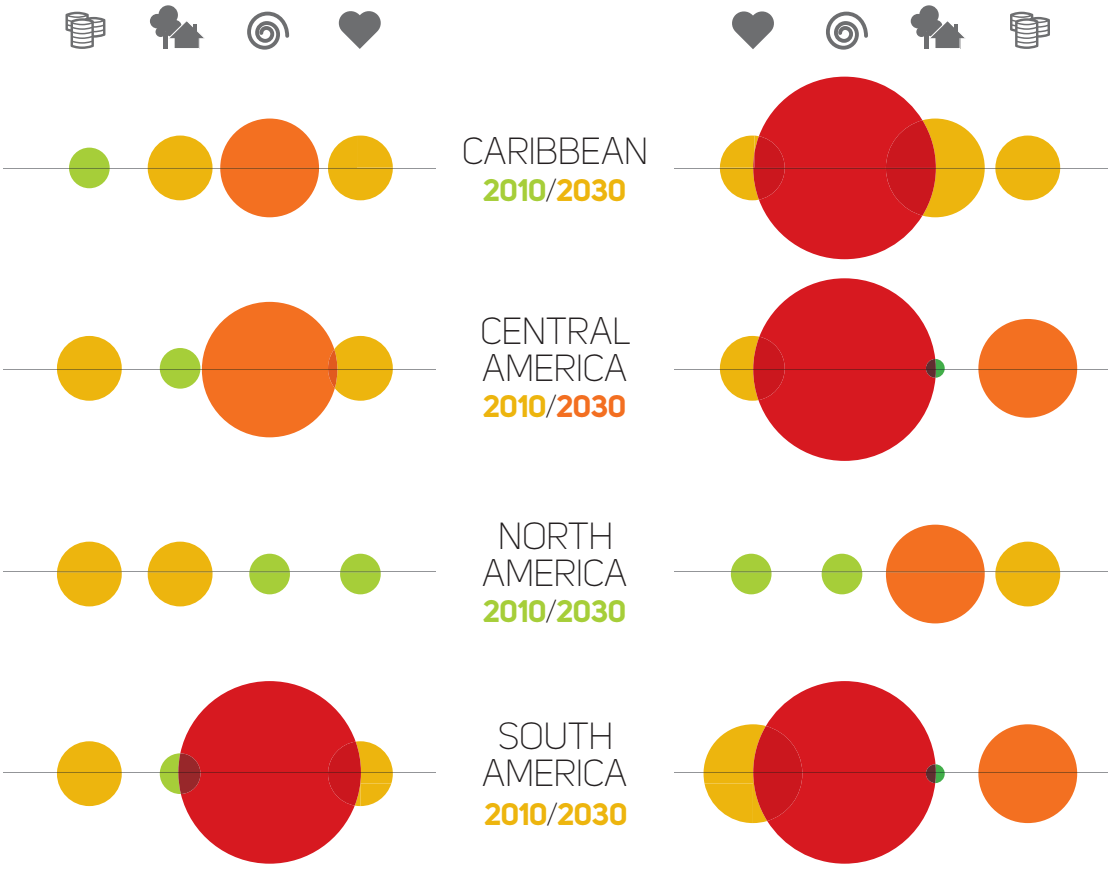

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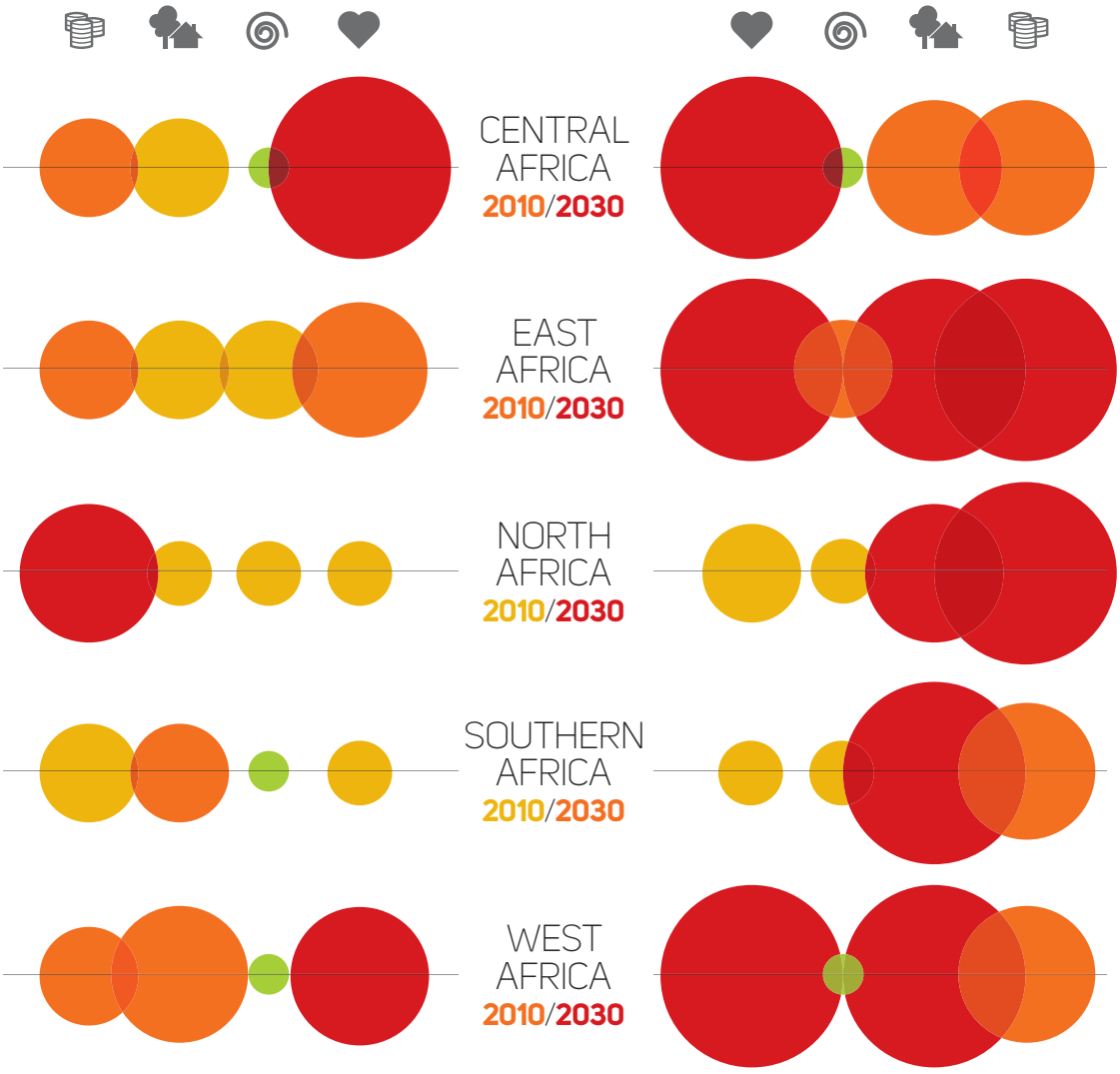

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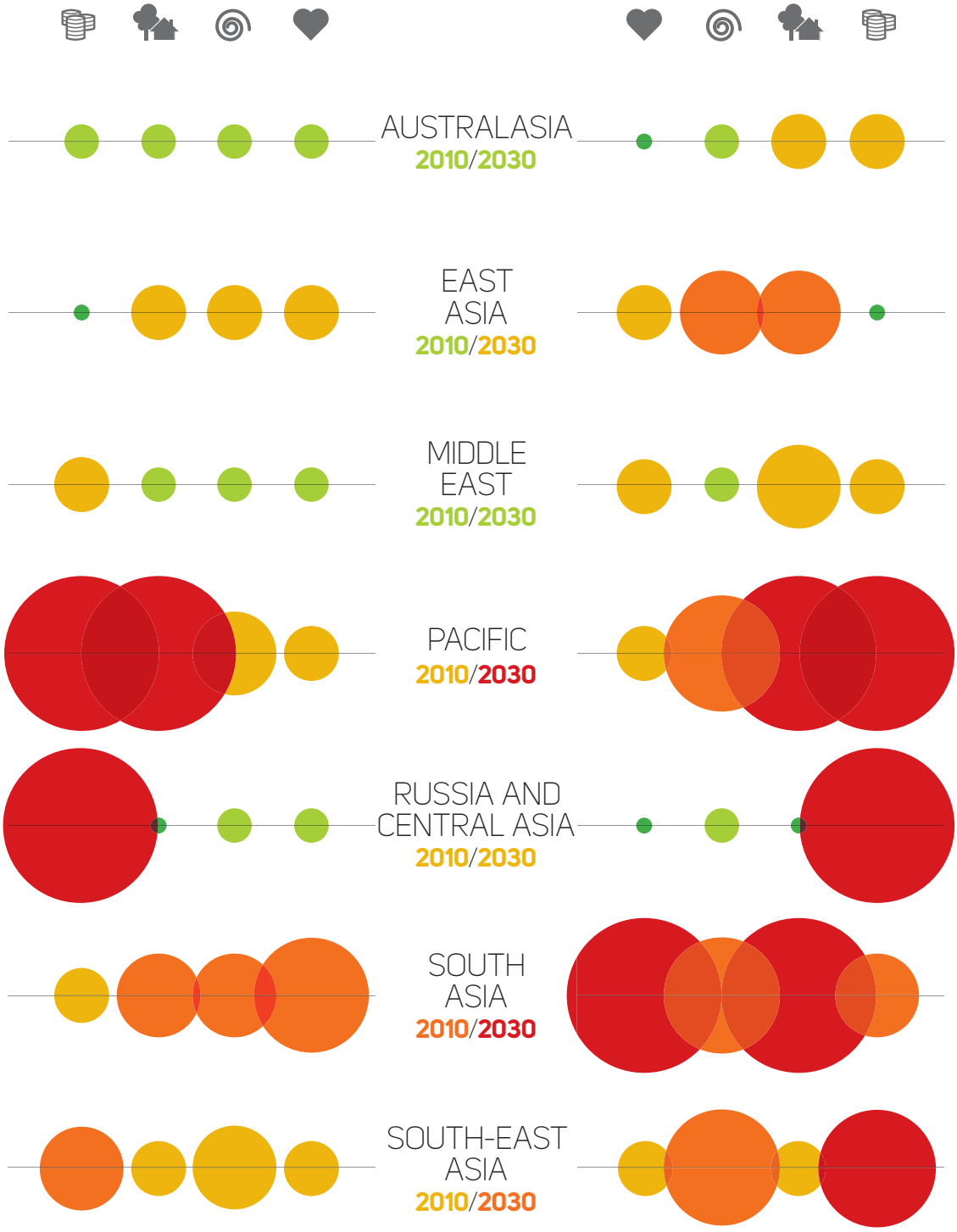

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EUROPE

EASTERN EUROPE
2010/**2030**

NORTHERN EUROPE
2010/**2030**

SOUTHERN EUROPE
2010/**2030**

WESTERN EUROPE
2010/**2030**

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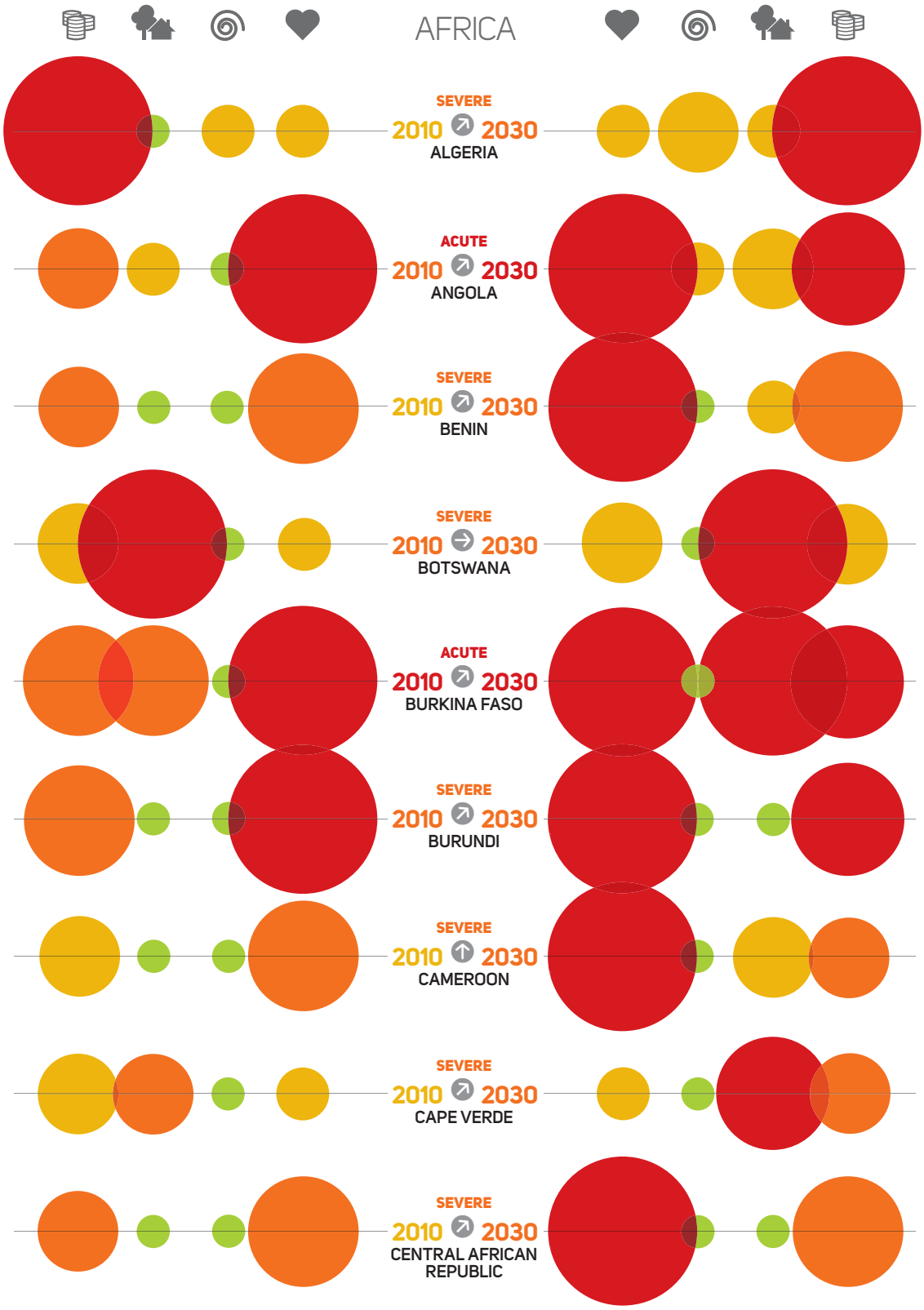

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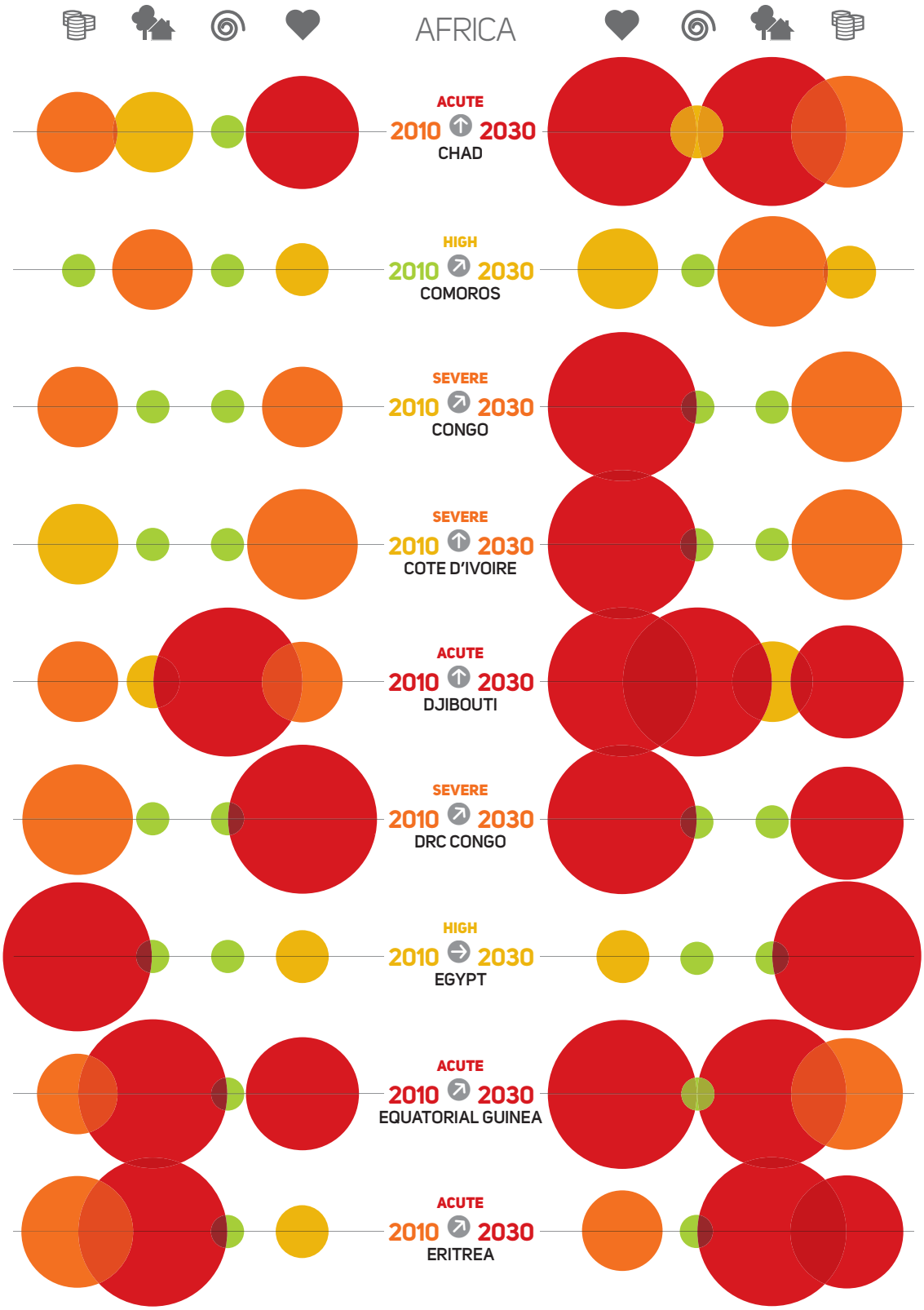

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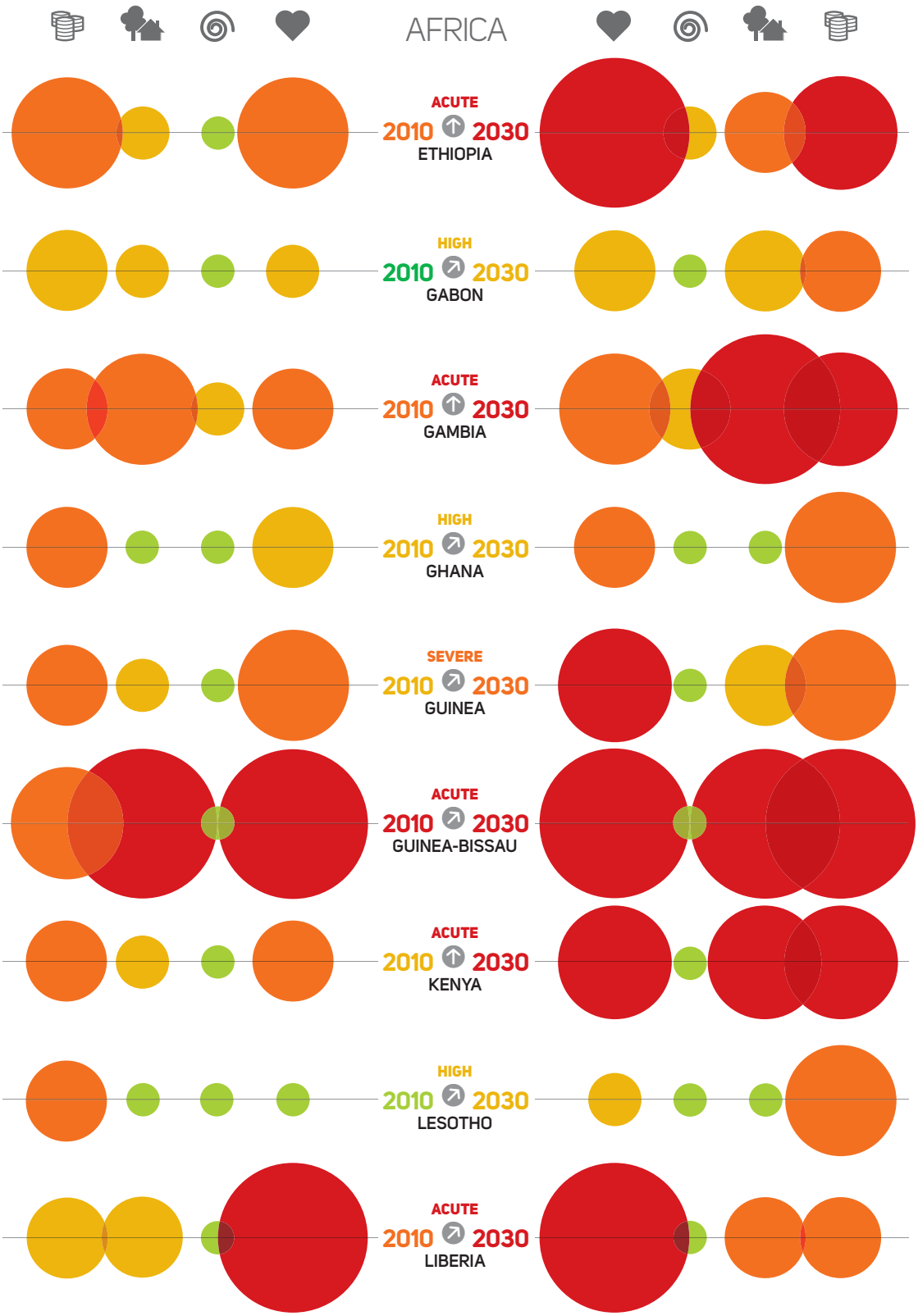

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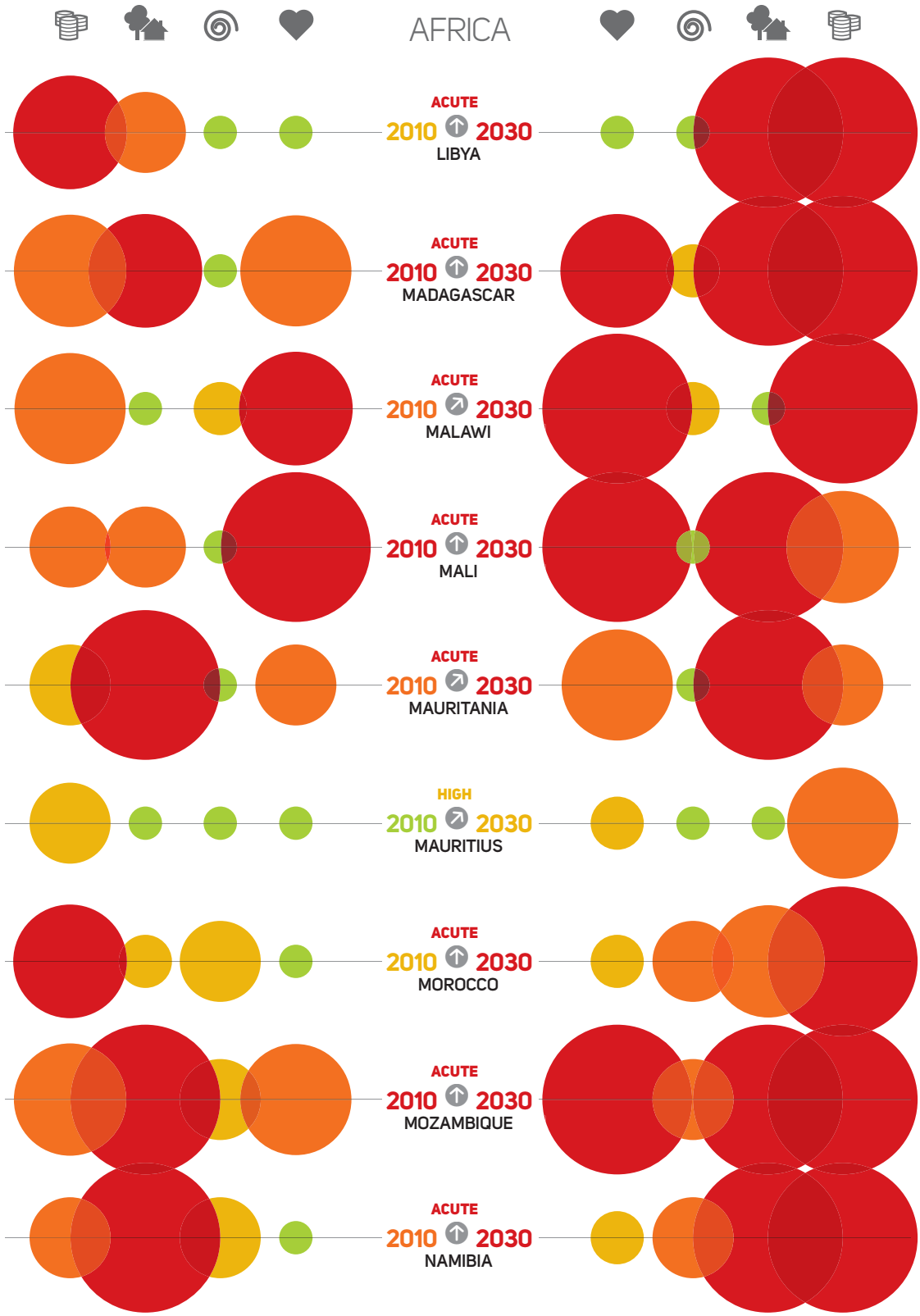

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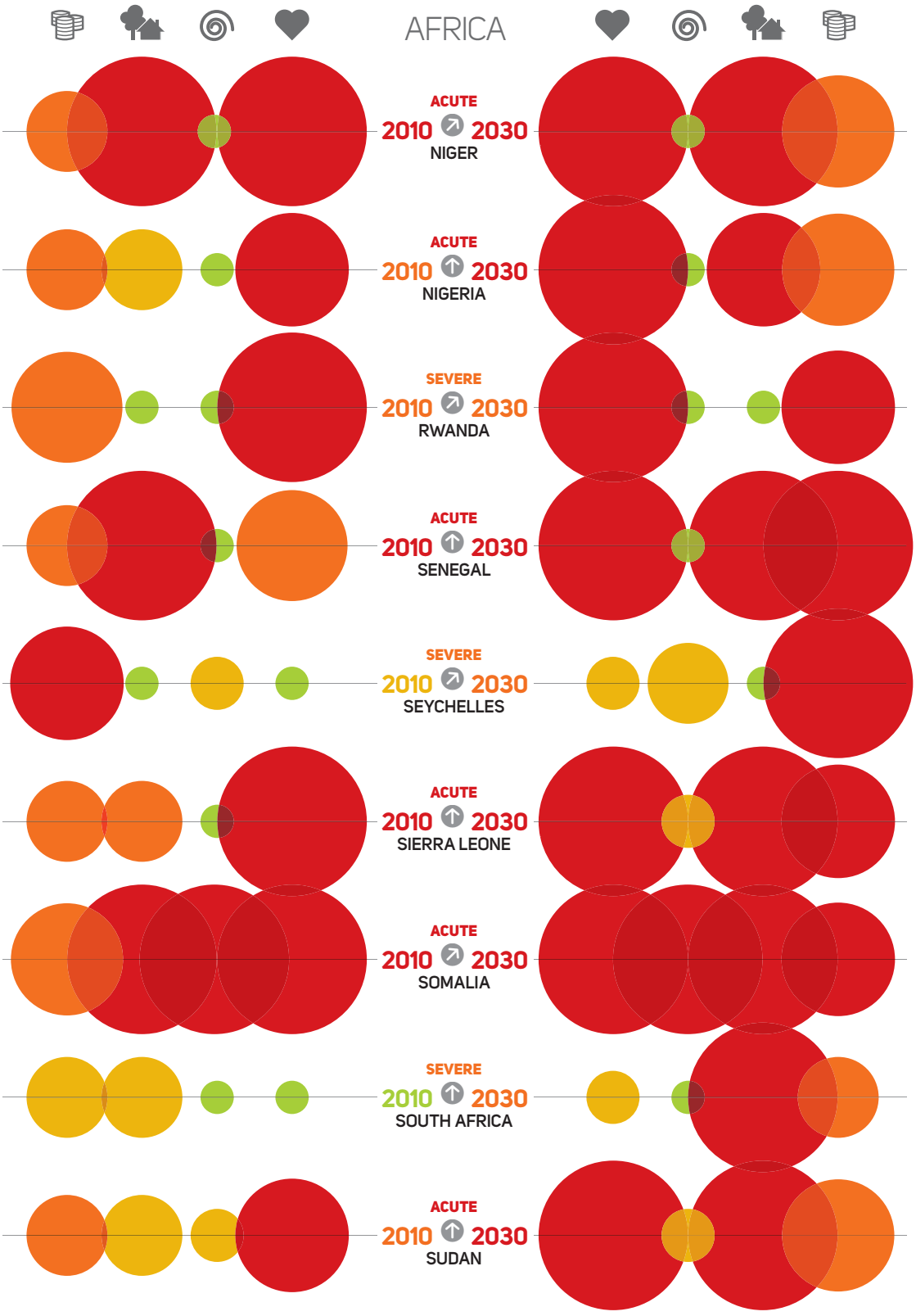

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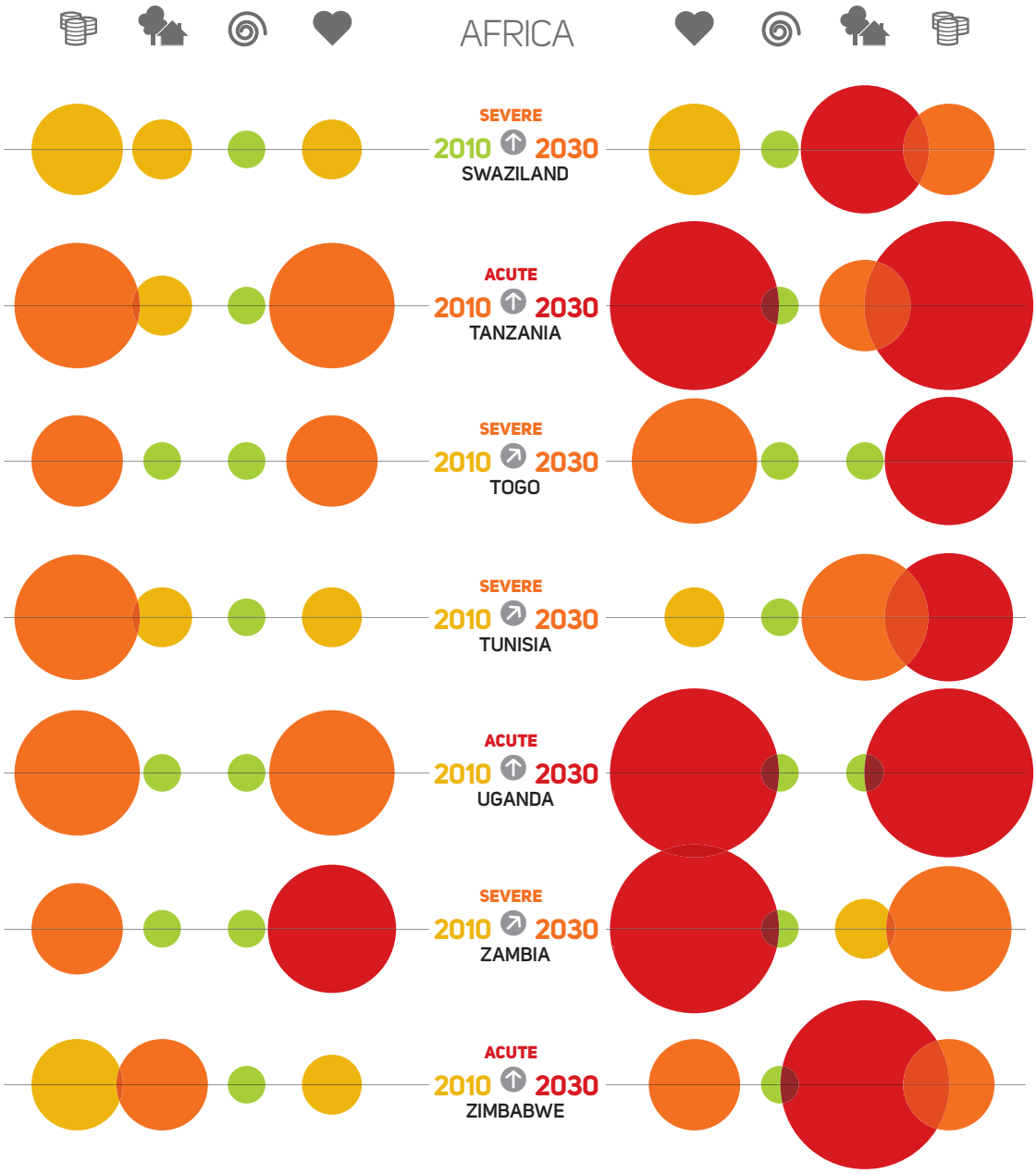

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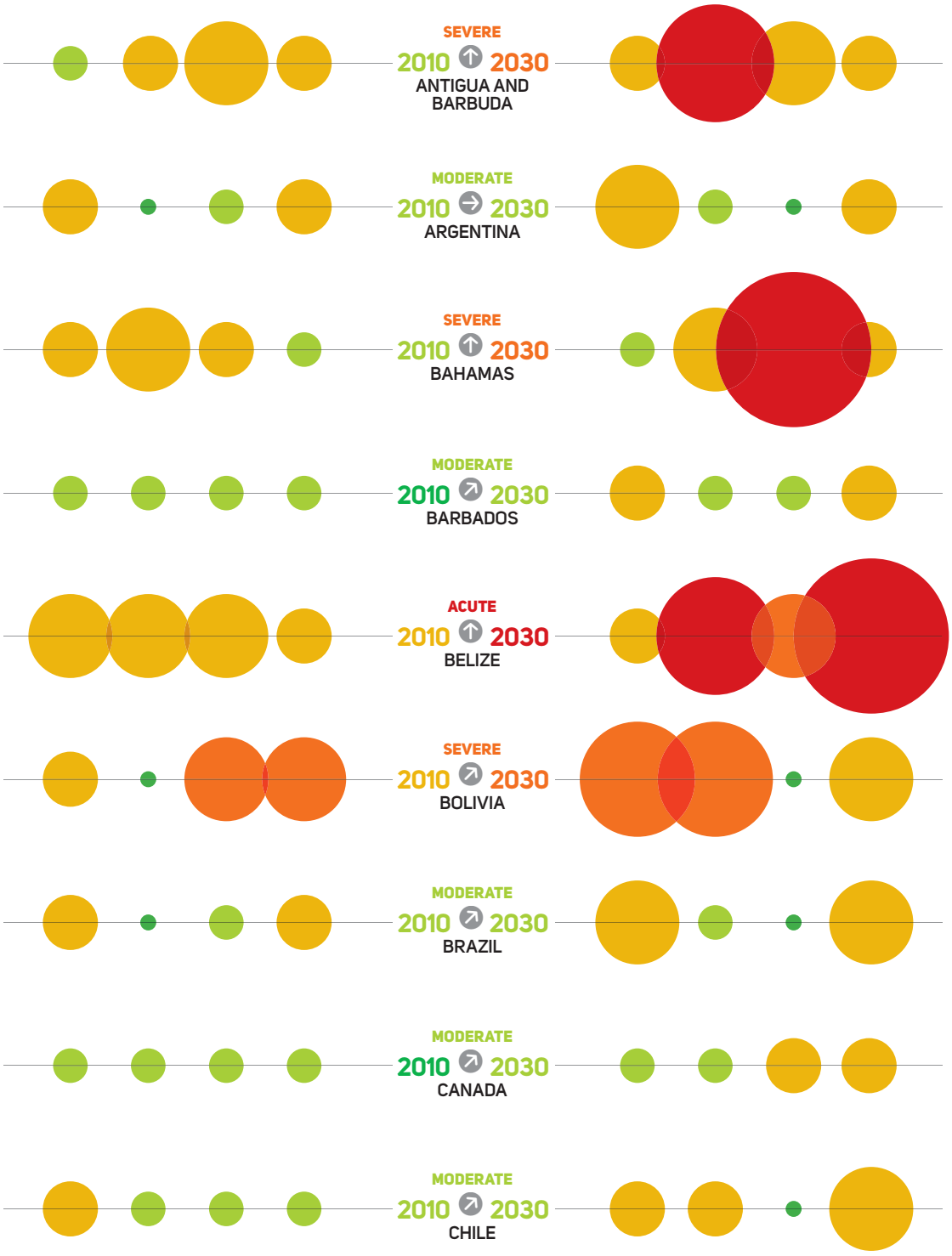

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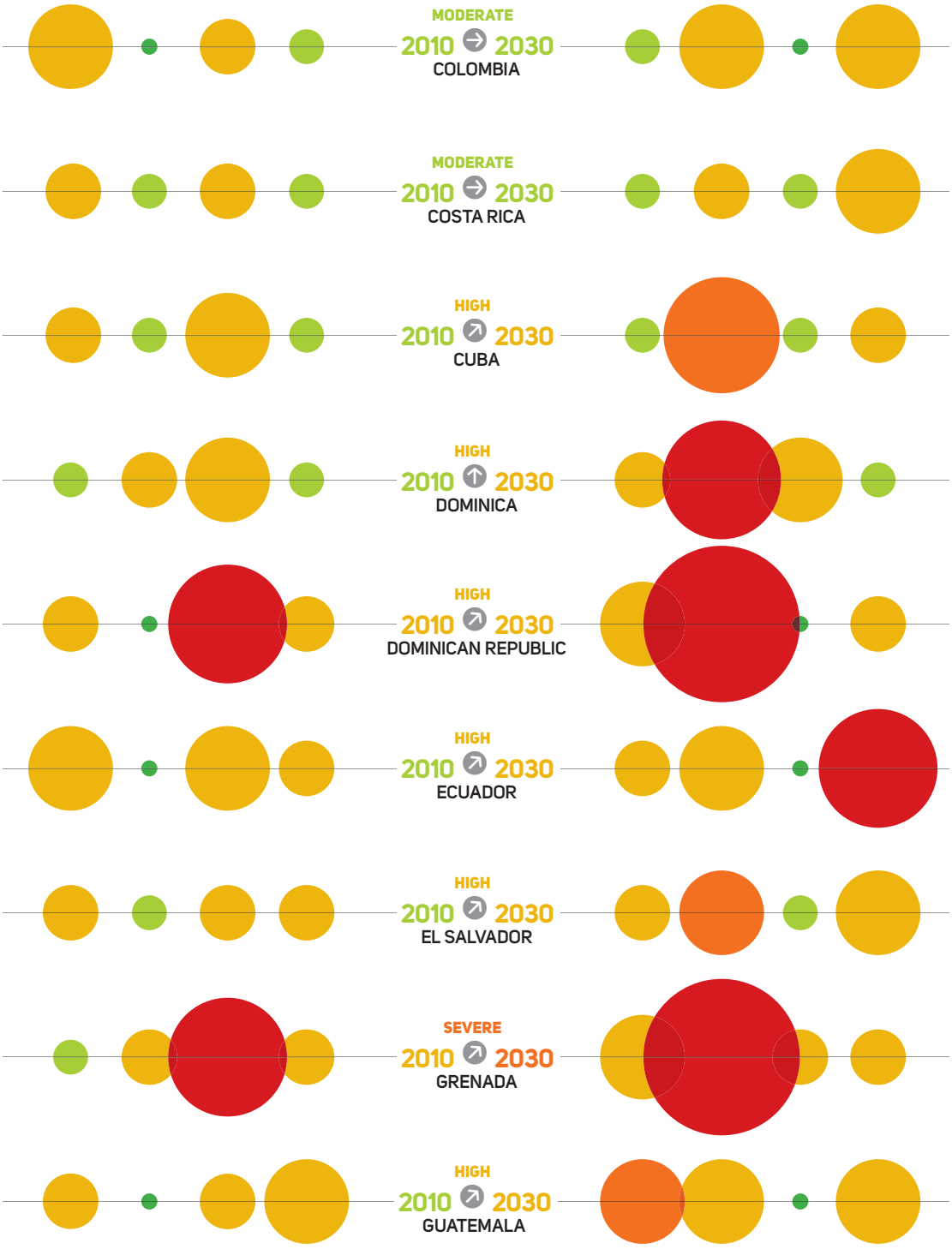

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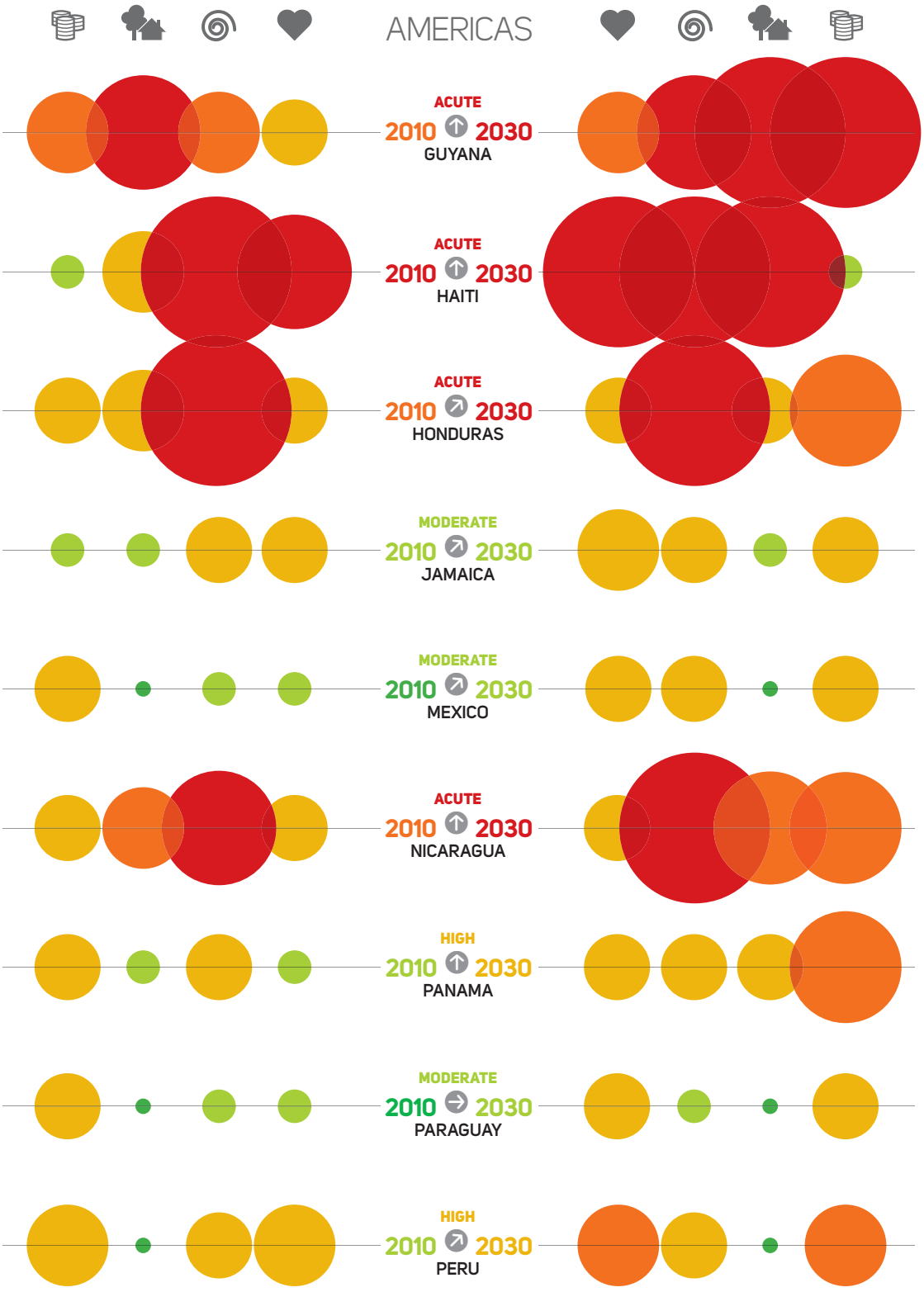

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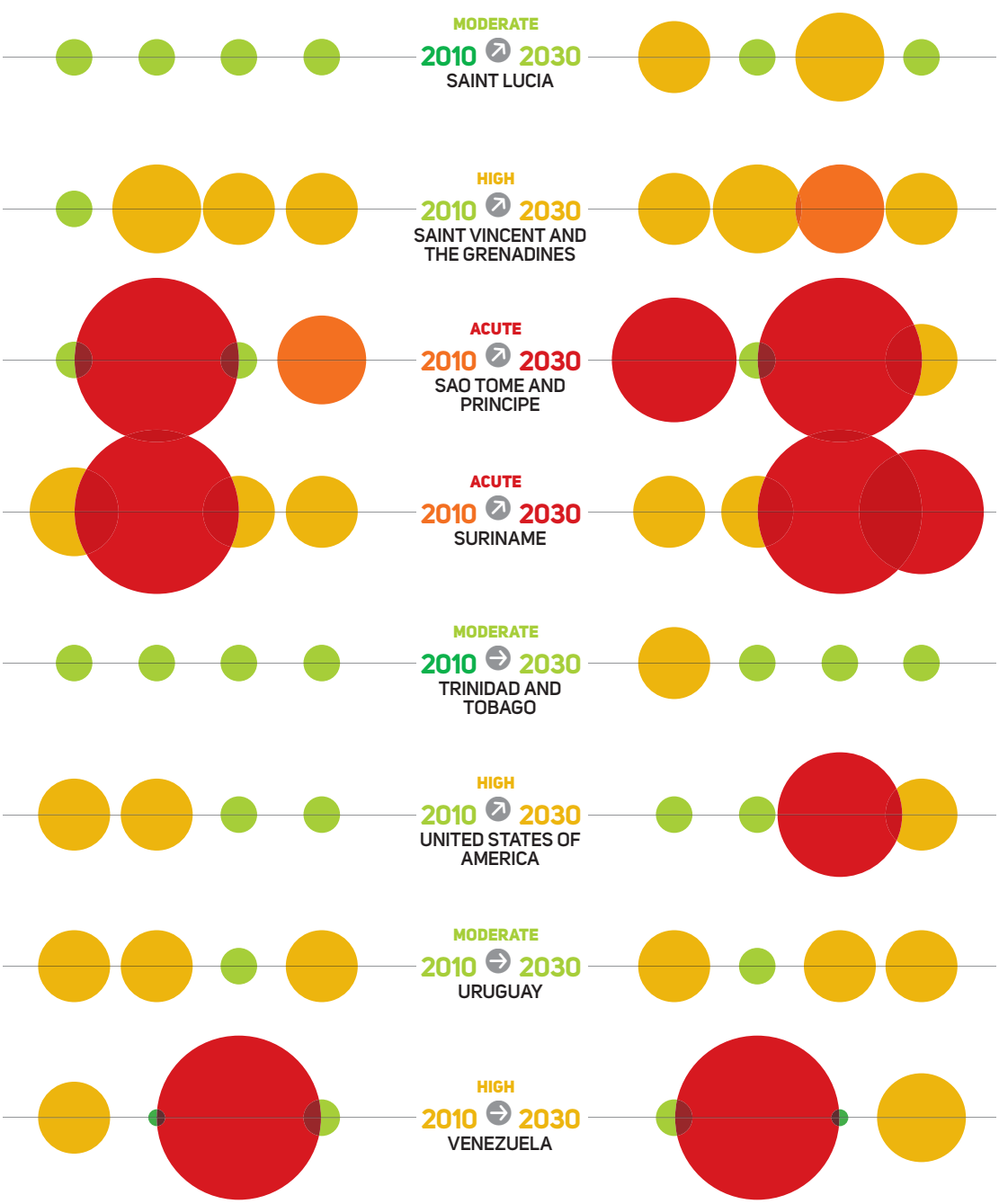

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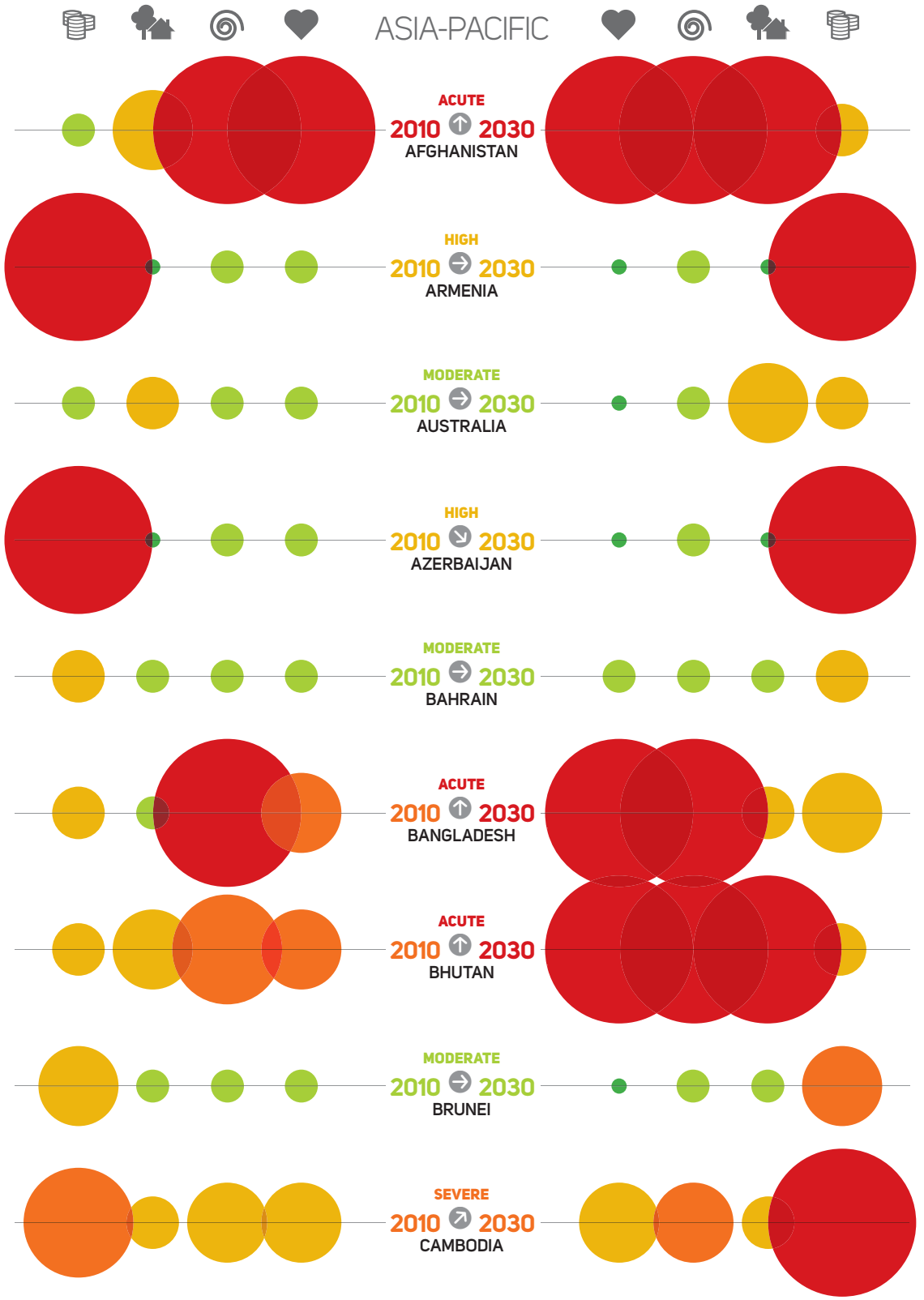

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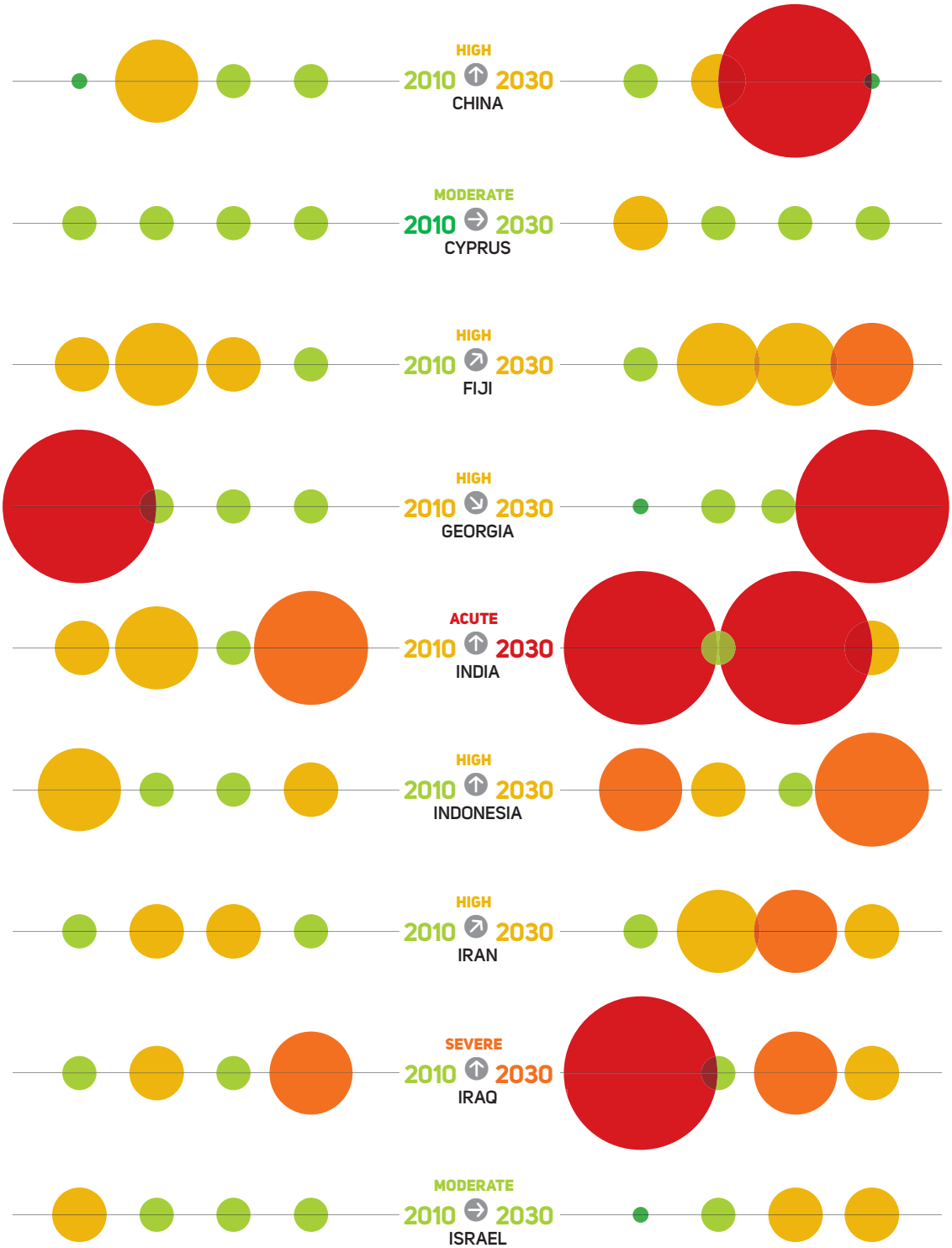

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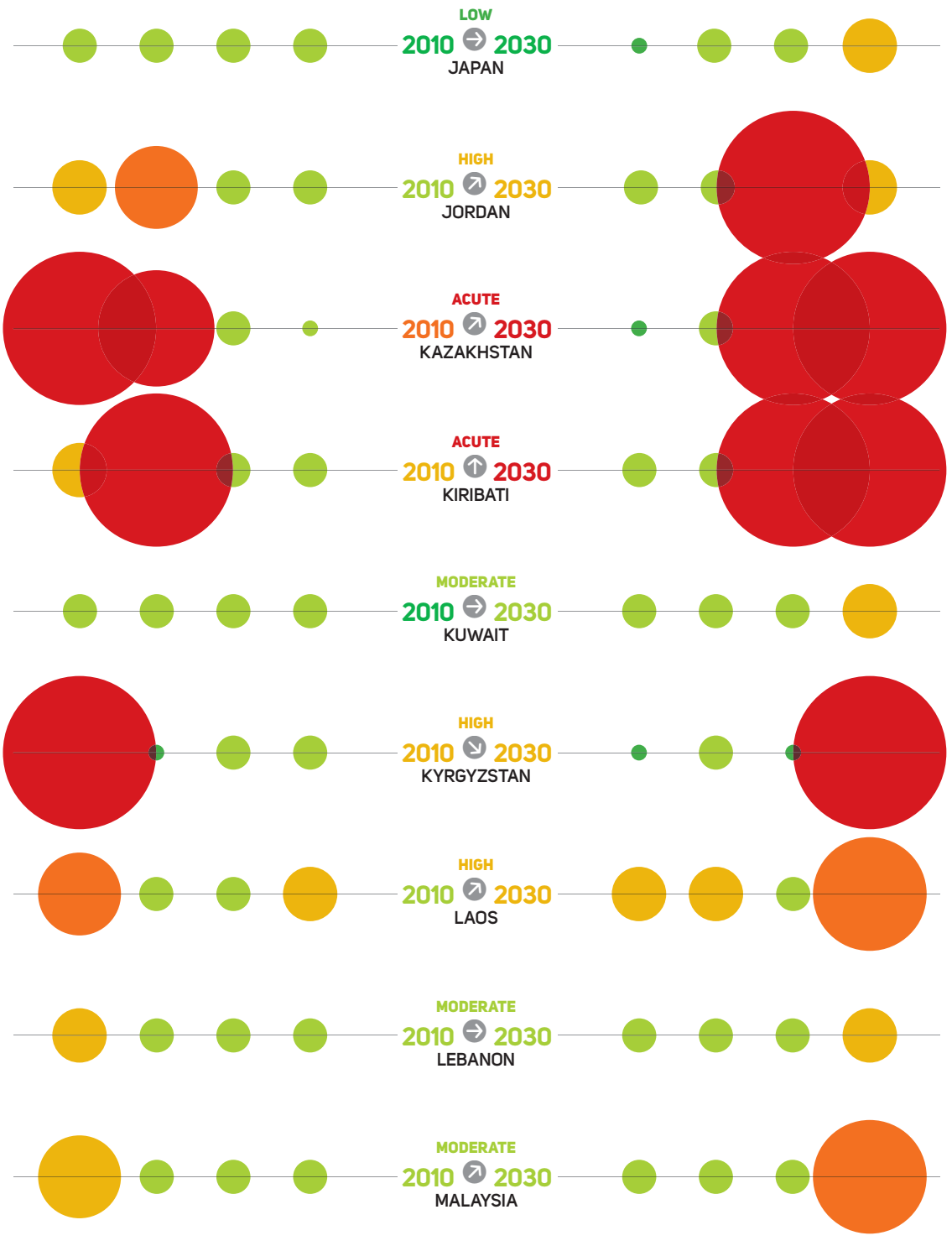

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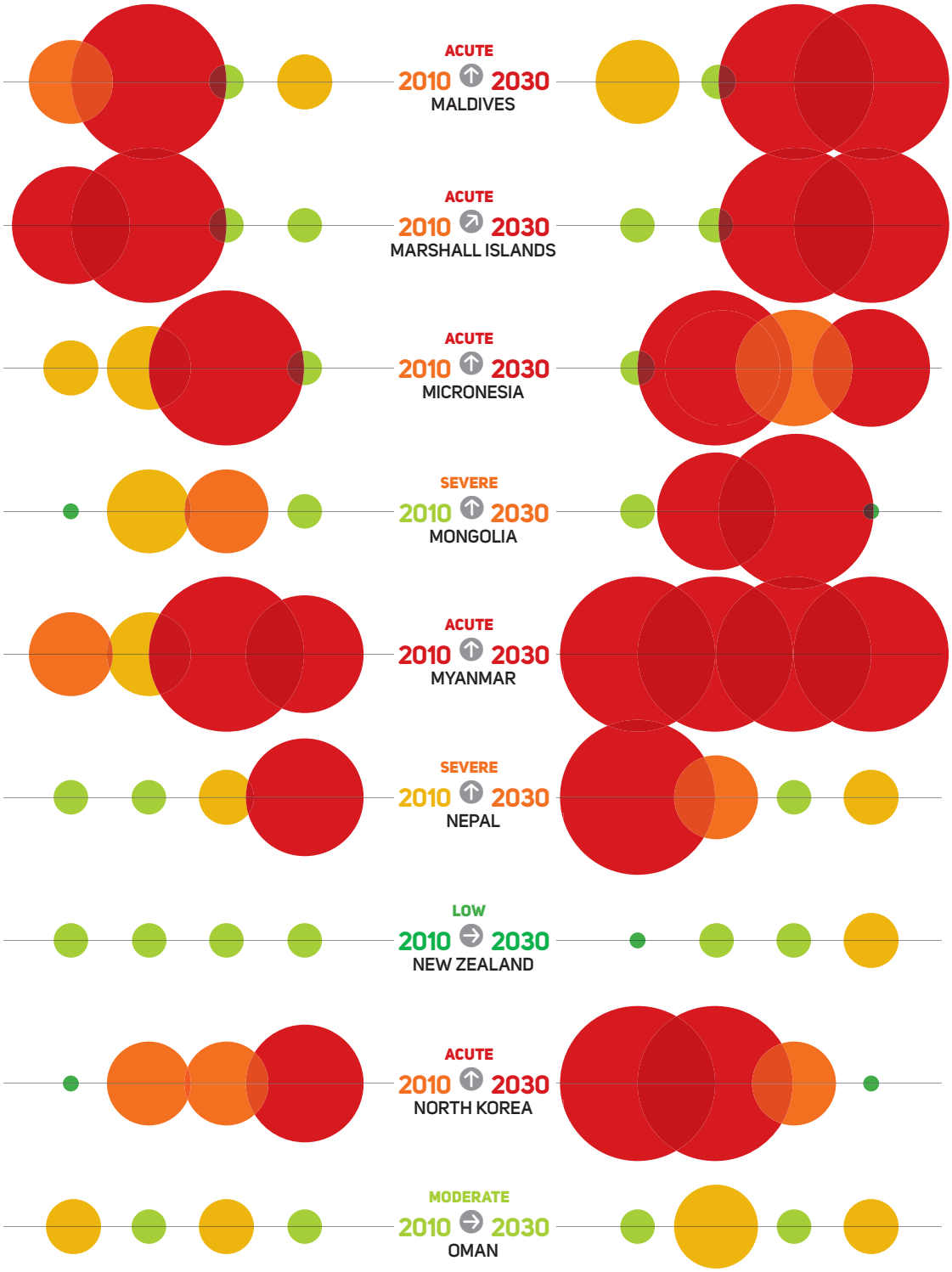

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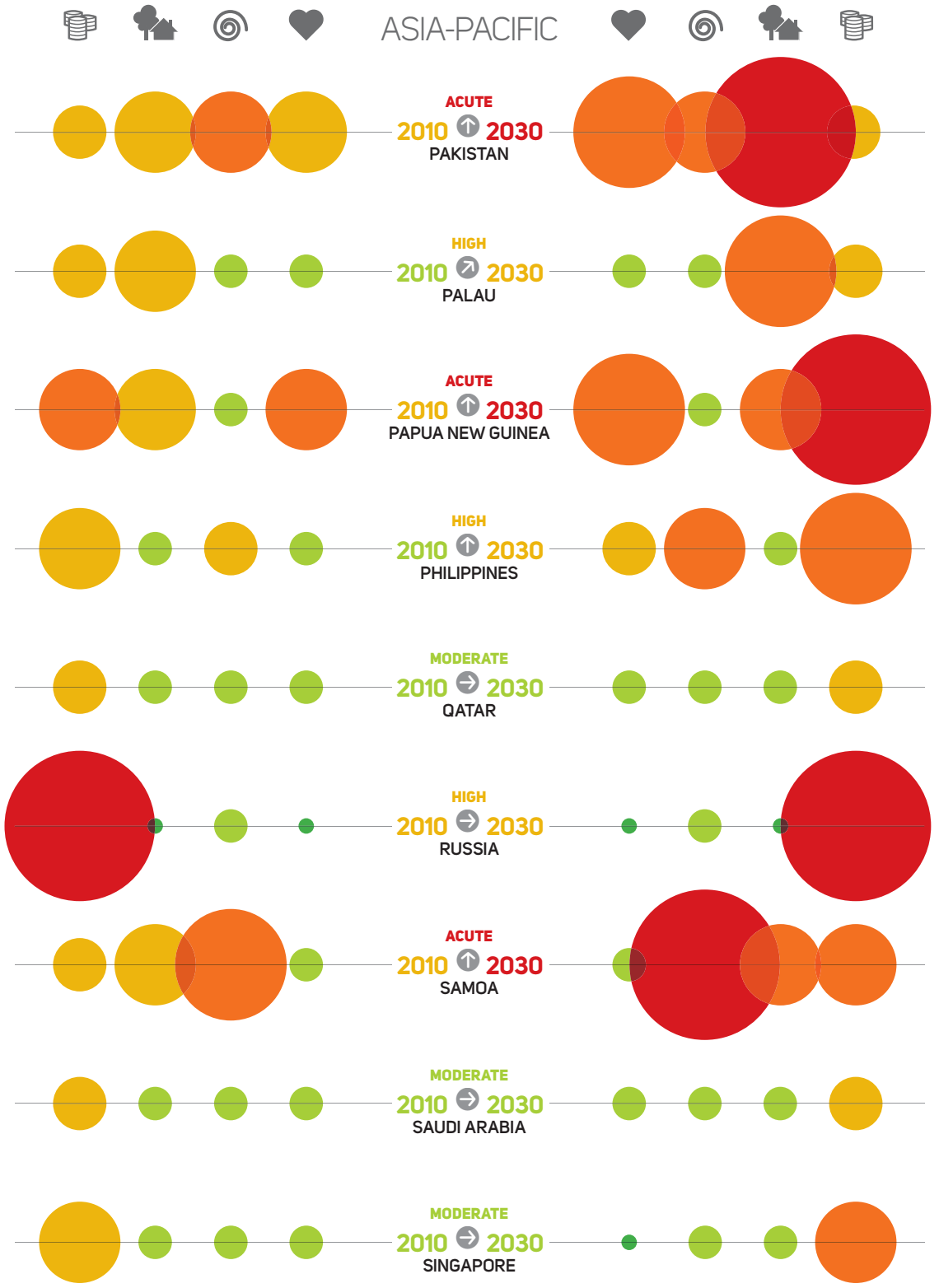

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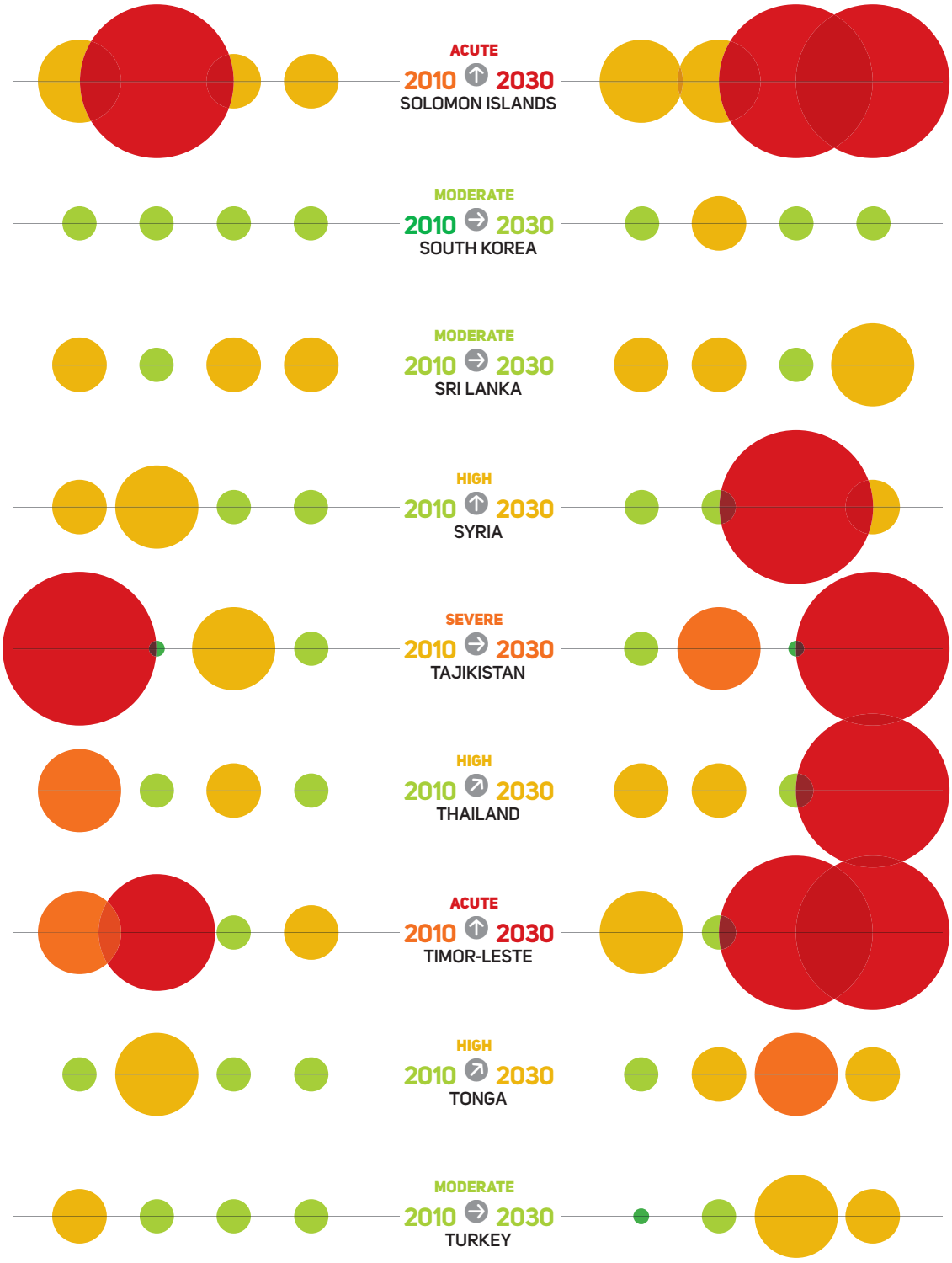

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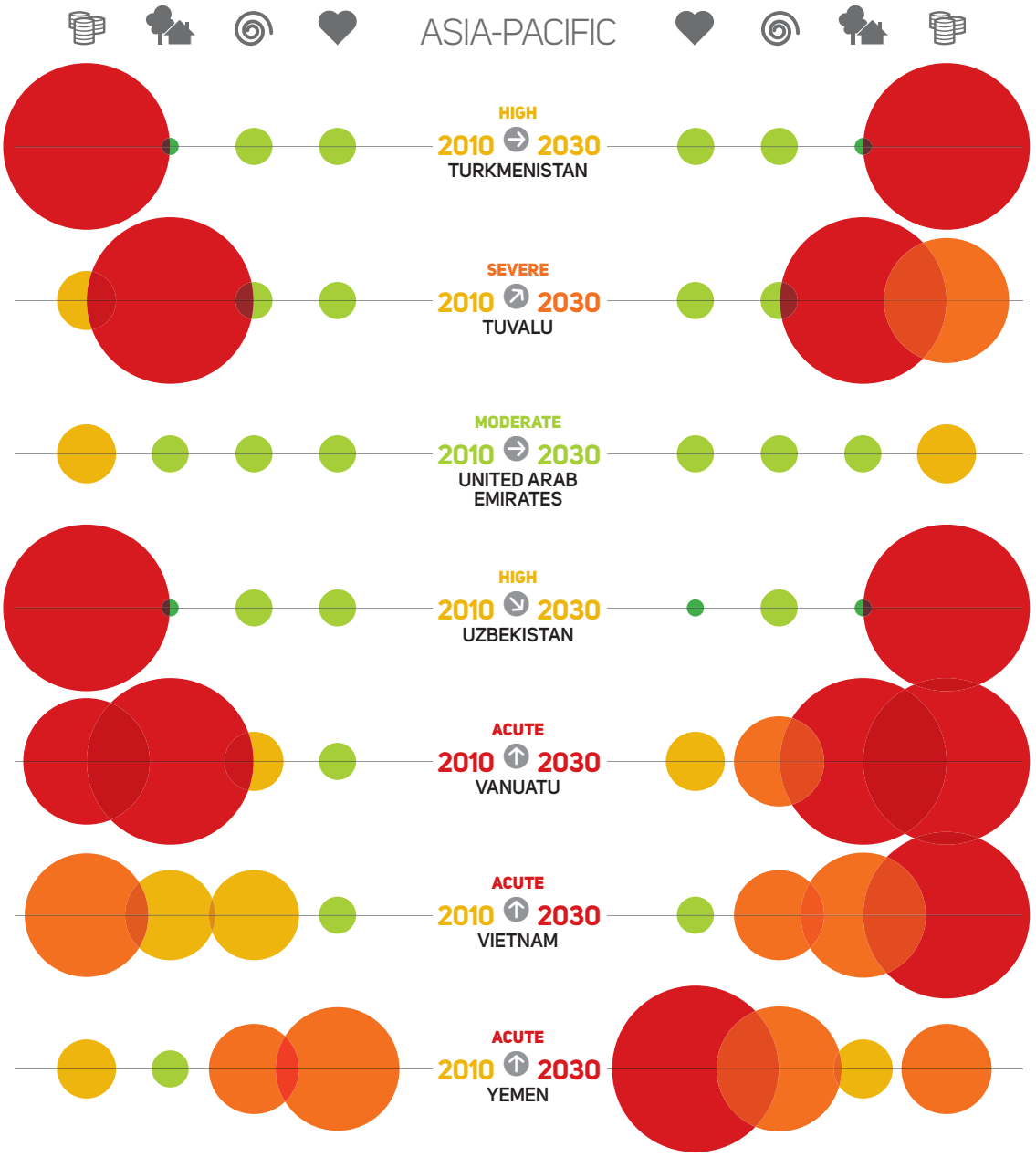

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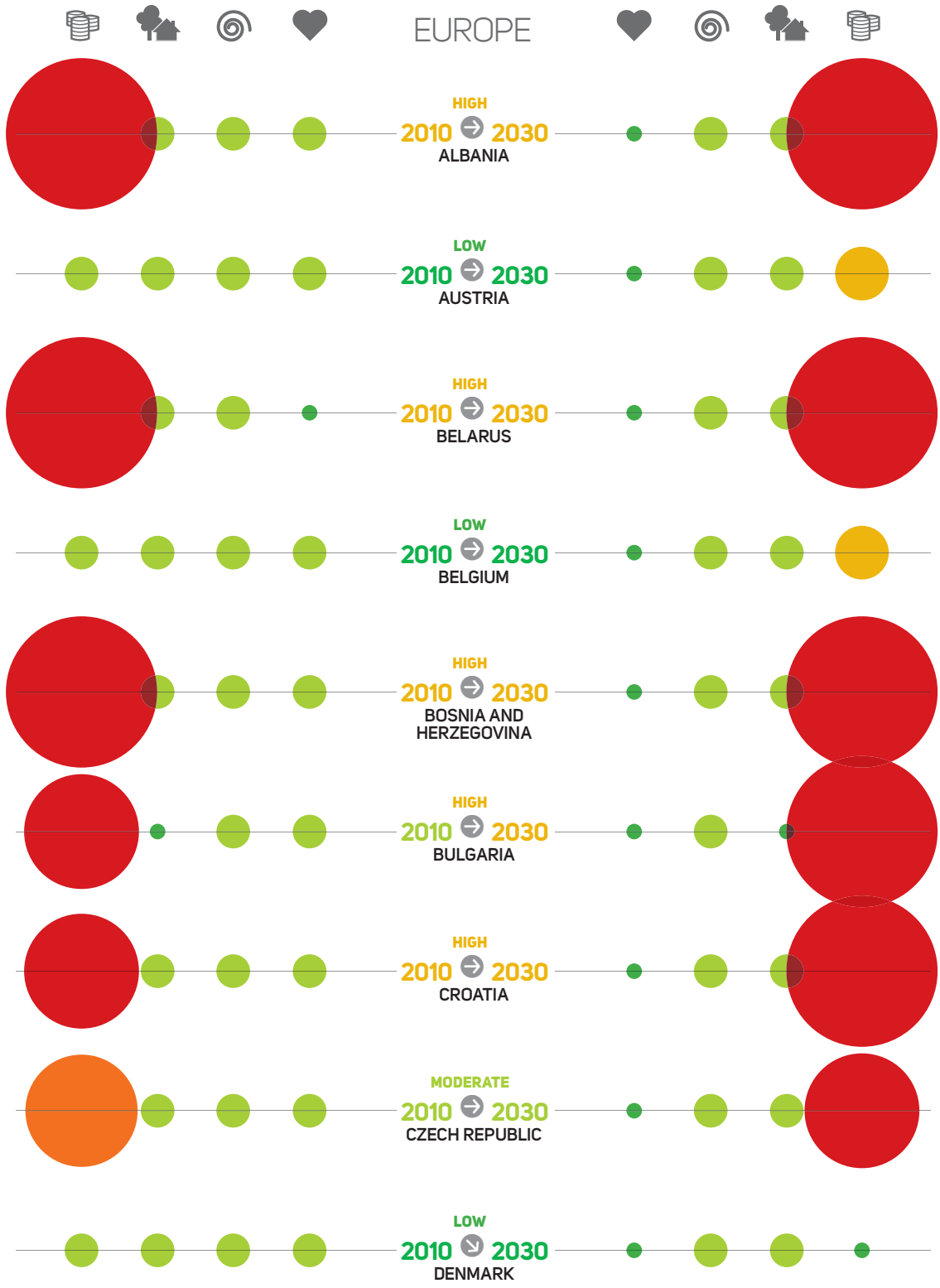

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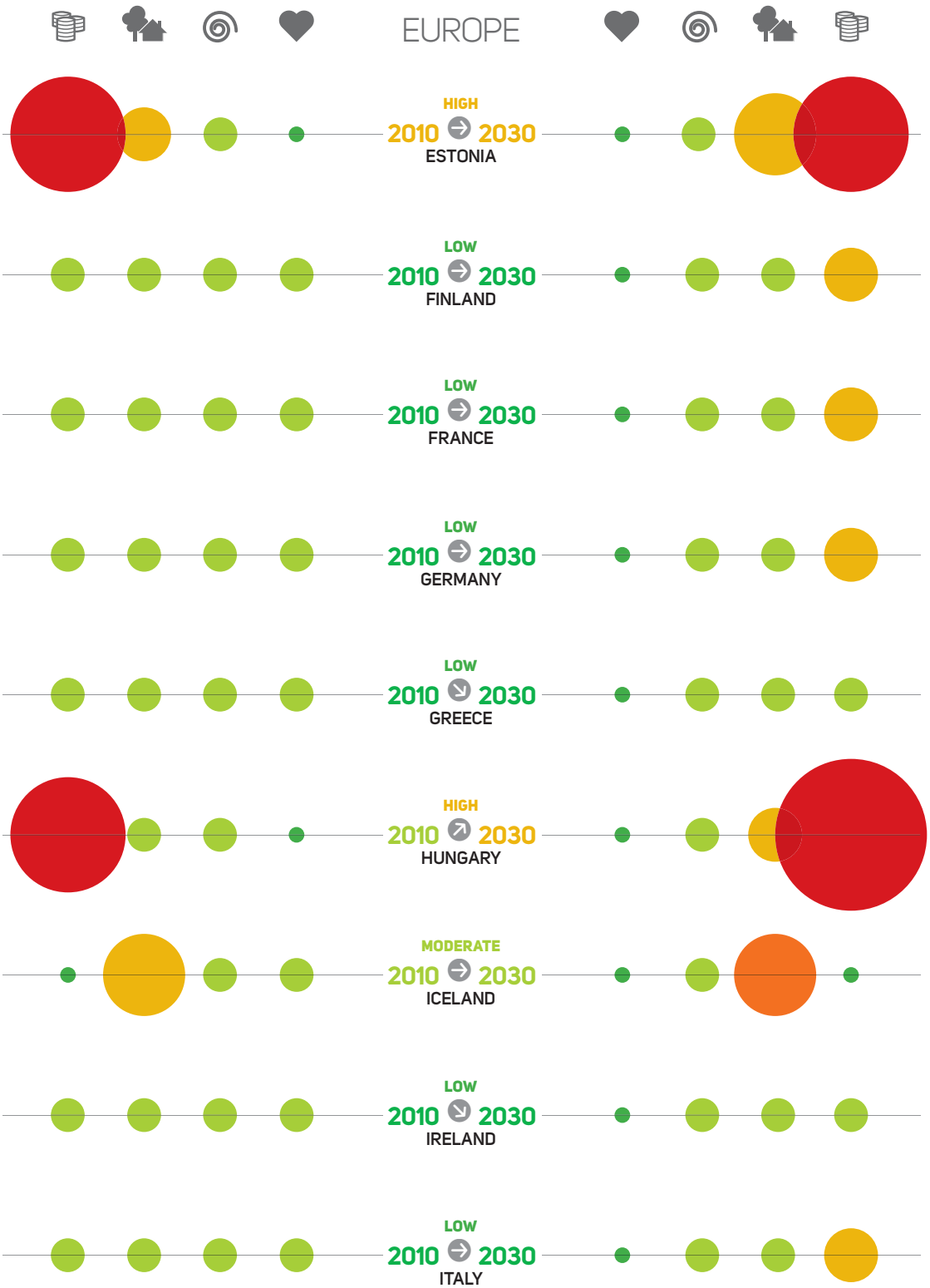

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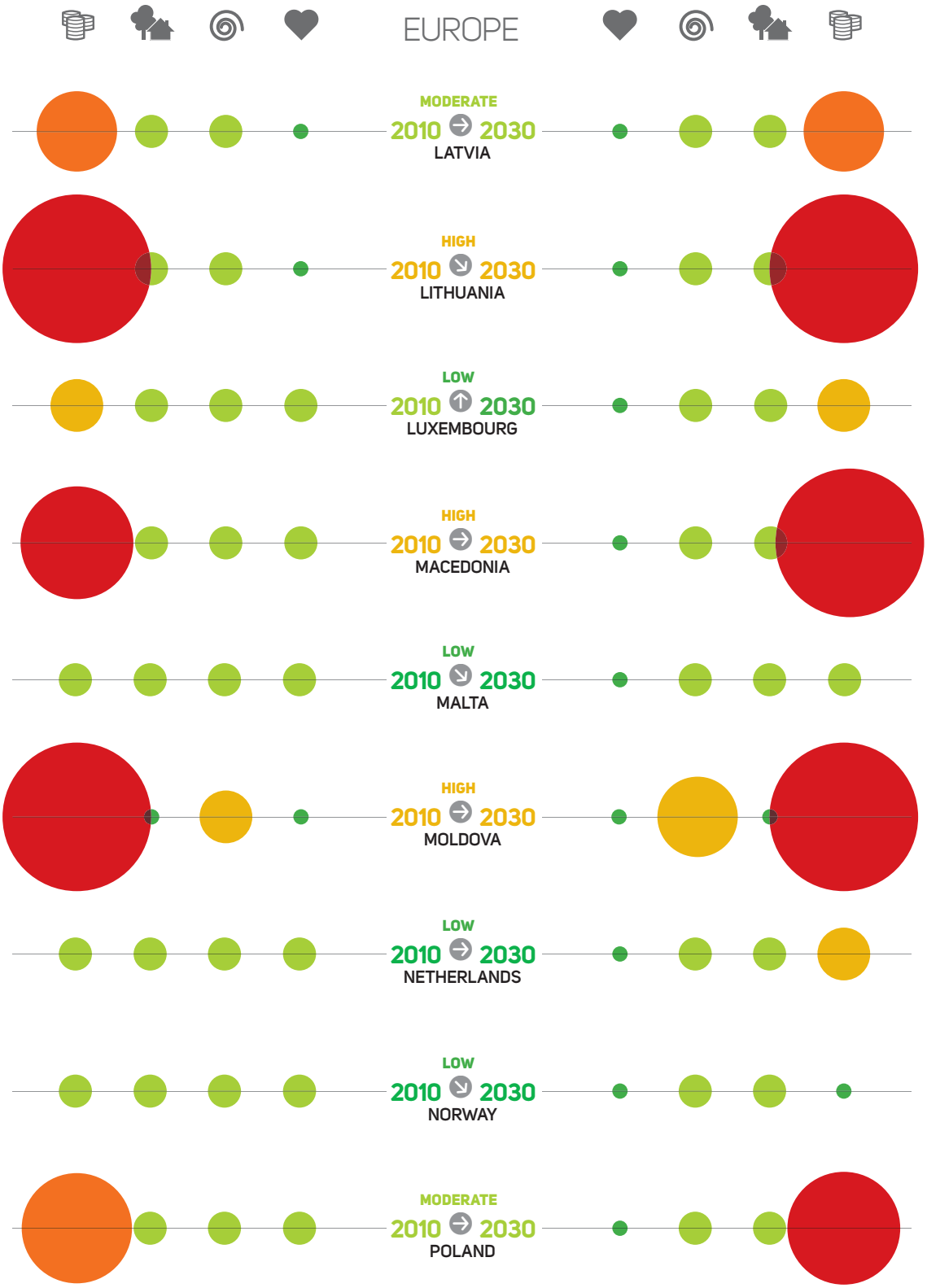
EUROPE



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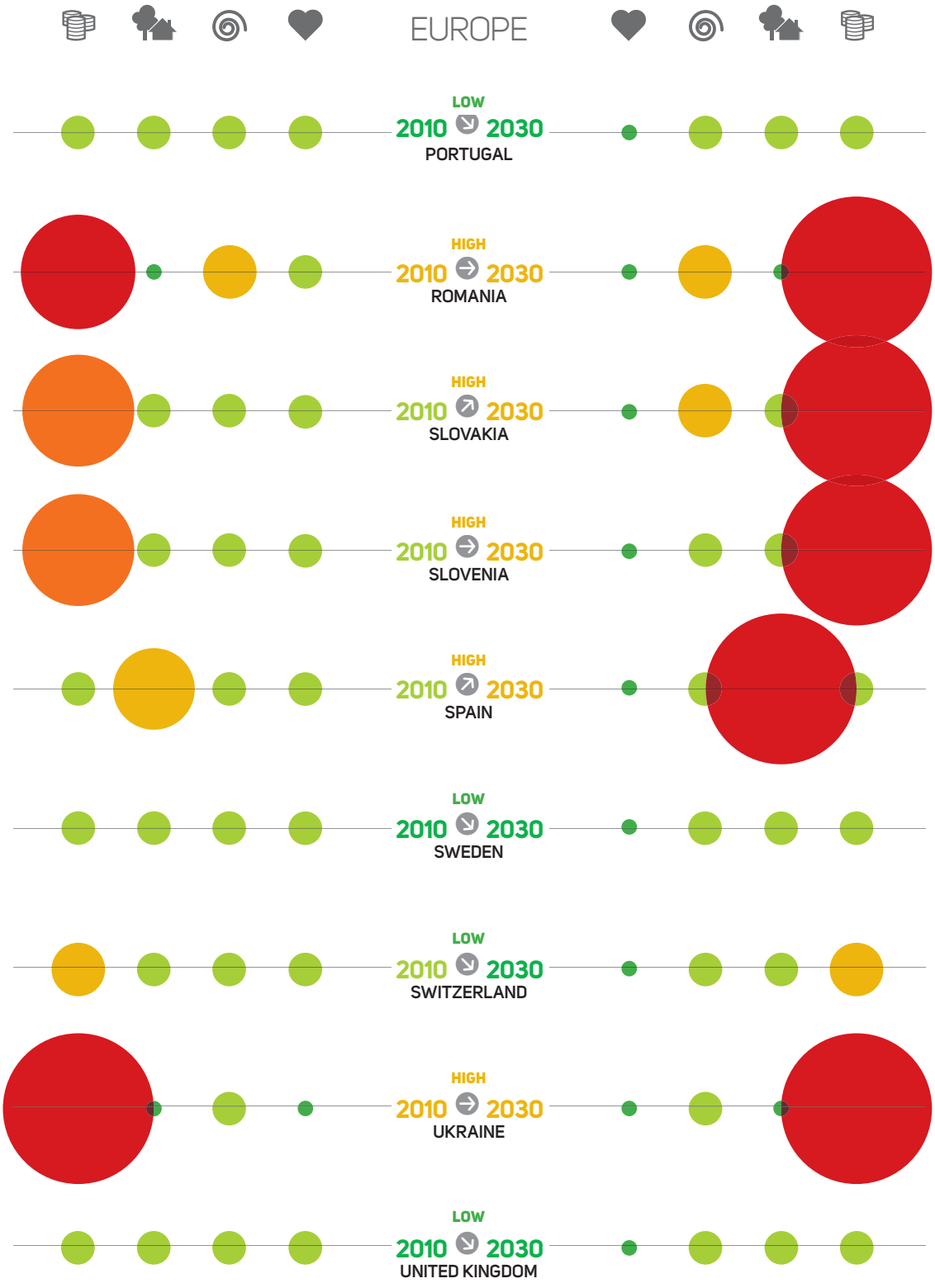

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WHAT IS THE MONITOR?

The Climate Vulnerability Monitor assesses the impact of climate change on 184 countries based on leading research. The impacts highlight where vulnerabilities to climate change lie. The Monitor measures effects across four main areas: Health Impact (deaths due to climate-sensitive diseases), Weather Disasters (deaths and damage caused by storms, floods, and wildfires), Habitat Loss (populations at risk to desertification and sea-level rise), and Economic Stress (industry and asset losses).

The Monitor combines the four main areas of impact and determines an overall factor of vulnerability, which is meant to be purely illustrative of the extent to which a given country is suffering from multiple climate stresses. Every country in the world thereby has its climate vulnerability profile assessed via the same set methodology. The Monitor recognizes five vulnerability levels, called "factors": Low, Moderate, High, Severe, and Acute. Factors give an indication of how vulnerable a country is to the effects of climate change in each of the impact areas, and overall. The Monitor provides factors overall and for today, in the year 2010, and in the near future, for the year 2030.

HOW THE MONITOR WORKS

DESIGNED TO ISOLATE KEY IMPACTS

Most existing indices of climate vulnerability employ some combination of socio-economic capacity set against meteorological and/or hydrological change.[9] The Monitor does not focus directly on capacity, nor in most cases directly on climate variables, since these in themselves do not pinpoint any impacts as they might occur, such as mortality linked to climate-sensitive diseases, or desertification aggravated by local climate shifts. So they have limited usefulness for targeting actual responses. The Monitor was developed to understand and highlight climate vulnerability in a way that could aid in the design of actions to avert harm to communities.

The Monitor identified four main types of impacts across the different areas of vulnerability that it assesses. These areas were chosen over others for various reasons. One, since each represents a distinct set of stresses that can be isolated from one another. A country like Rwanda, for instance, could have serious health impacts but suffer no marked desertification or sea-level rise impact, and it is not affected by tropical cyclones or major floods due to glacial melt. Two, since for each of the different impact areas, we also outline distinct types of measures that can be taken to reduce the negative effects. And three, because each of the main elements of the four different impact areas included data sets of globally available information and in many cases models that already existed estimating the relationship between the underlying variable and climate change. As a result though, the Monitor is not fully comprehensive in that certain impacts are excluded. Some of the measurements are also restricted in the information they provide -- such as mortality only in extreme weather as opposed to numbers of people affected or displaced -- so impact estimates should be treated as indicators of a wider problem.

Many countries also register severe impacts across a range of categories. Eritrea for instance, suffers both sea-level rise impacts and desertification and is highly vulnerable to the health impacts of climate change. These are multiple-stress countries, where several impacts are brought to bear in one place, seriously compounding one another. We have included an overall vulnerability factor for each country, since it captures a sense of these multiple stresses. However, the overall factor has been compiled with an even weighting from across the four impact areas. Fair arguments could well be made in favour of, for example, a much higher weighting for impact areas where human lives are at stake. Elsewhere, countries with very high vulnerability in just one impact area may feel de-prioritized, or that the rigid split is prescriptive in terms of existing national strategies. As such, the overall vulnerability factor should not be used for planning purposes or to prioritize responses. Responses need to focus on tackling vulnerability as highlighted in the individual impact areas. The overall vulnerability level referred to in the report is based on 2030, since while information

THE MONITOR WAS DEVELOPED TO UNDERSTAND AND HIGHLIGHT CLIMATE VULNERABILITY IN A WAY THAT COULD AID IN THE DESIGN OF ACTIONS TO AVERT HARM TO COMMUNITIES

is estimated for 2010, it in many cases relies on base information several years old. Furthermore, 2030 impacts are inevitable without remedial actions due to the unstoppable warming in the climate over the next 20 years.

In each of the four impact areas, we have assigned a "climate effect" to a given region, which estimates the role of climate change in driving diverse impacts. The climate effect reacts to existing societal characteristics, such as widespread climate-sensitive diseases like malaria, frequent large-scale storm or flood damage, or comparatively large agricultural sectors. Underlying vulnerabilities that react to climate change vary from country to country, and with them vulnerability to climate change itself. The most recent expertise and models provide indications for these reactions in different parts of the world. Nevertheless, where there is a higher concentration of the types of vulnerabilities that are most sensitive to climate change, we have rated vulnerability higher.

CLIMATE VULNERABILITY MONITOR ARCHITECTURE

	HEALTH IMPACT	WEATHER DISASTERS	HABITAT LOSS		ECONOMIC STRESS	
			DESERTIFICATION	SEA-LEVEL RISE	LAND	MARINE
UNDERLYING VULNERABILITY	Existing Levels of Climate-Sensitive Diseases	Prevalence of Historical Casualties and Damage	Scale of Populations in Arid Regions	Scale of Vulnerable Shoreline and Coastal Communities	Size of Agriculture Sector, Sensitivity of Water Resources, Vulnerable Species/Non-Human Habitats	Size of Fisheries Sector, Coral Reef Abundance
MAIN CLIMATE RISKS	Heat and Flooding	Floods, Storms, and Wildfires	Heat, Rainfall Loss, Drought, Winds	Ocean Water Levels, Salt Intrusion	Heat, Rainfall Loss, Drought, Mid-Latitudes	Ocean Warming and Acidity
INDICATOR USED	Additional Deaths from Key Climate-Sensitive Diseases	Additional Deaths and Damage Costs from Floods, Storms, and Wildfires	Additional Populations at Risk	Cost of Protection and Land Loss	Sector/Industry and Asset Losses	Sector /Industry Losses
DATA SOURCES	World Health Organization (WHO)	CRED EM-DAT and Munich Re NatCatService	PLACE II	DIVA	FUND	World Resources Institute
MODELS	WHO HadCM2 global	WHO and Estimated*	IMAGE 2.2	DIVA	FUND2.8n	Estimated*
EMISSION SCENARIO	s750	Hypothetical* and s750	Average of All IMAGE Models	A1F1	EMF14 (IS92a/ IS92f)	SRES A1B
KEY VULNERABILITY DRIVERS	Human Development Gender Development Governance Systems Public Services Resources Management/Stocks (Water, Land, Marine) Insurance Coverage Infrastructure Placement/Design			**KEY EXPOSURE DRIVERS**	Demographics Geography Existing Climate Conditions	

*Urgent requirement for scientific quantification of changes taking place

To establish the scale of societal characteristics across countries, the Monitor very simply looks from country to country at historical records or satellite observations of phenomenon we know are influenced by climate change. The historical record is assumed to provide a good indicator of the ongoing state of underlying climate-sensitive vulnerabilities in a given country. These include coastal areas exposed to sea-level rise or lands prone to desertification. Also included are communities suffering from climate-sensitive infectious diseases, damages registered as a result of extreme weather, and key economic sectors or natural resources knowingly affected by changes in climatic conditions, such as agriculture, fisheries, and water supplies.

CURRENT AND SHORT-TERM VULNERABILITY: A NEW PERSPECTIVE

The Monitor assesses vulnerability overall and for 2010 and 2030, providing an idea of what responses are needed today and how quickly they will have to expand in the coming years. Most existing climate vulnerability assessments have been carried out with a longer-term focus. Countries highly vulnerable in 2050, 2080, or 2100 will only register as vulnerable in the Monitor if they are also

expected to be exposed to climate shocks in the very near term. Since many countries have already begun to familiarize themselves with their own vulnerabilities on the basis of longer time scales, they may well be surprised when viewing that vulnerability on a much shorter time horizon. Some parts of Africa and the Americas, for example, may benefit from increased rainfall in the short term.[10] In other instances, countries that would have high vulnerability at the end of the twenty-first century are not the same as those countries with a high vulnerability today. Sea-level rise, for instance, is now slightly more than 3mm, or a fraction of an inch every year. Over 20 years, that would amount to about 7cm or 3 inches. This compares to worst scenarios of some 200cm or 80 inches of possible sea-level rise by the end of the century, with radically different vulnerability and climate impact outcomes as a result.[11]

Impacts have been estimated in either economic terms, for example, as a share of costs from, say, flood damage or losses/gains in productive output. Or they are expressed in human terms, such as populations under stress due to desertification, or mortality as a result of more severe weather or disease. The same methodology is applied to all countries, so the level of vulnerability ascertained is roughly comparable from one place to another.

If some steps have already been taken to adapt to changes -- such as disaster-reduction measures in Bangladesh that have greatly reduced fatalities during major storms -- a lower vulnerability will be registered. The longer in the past any such actions were taken and continuously maintained, the more likely they are to have an effect on the vulnerability factor of the country concerned.

Not taken into account is the level of domestic/international resources available to a country to deal with these challenges. And so the United States, for example, registers similar vulnerability levels to Gabon or Tonga, despite fundamentally different degrees of capacity available for confronting these vulnerabilities.

EFFECTS CAN ALSO BE POSITIVE

Climate change does not only have a negative impact. Agriculture, for instance, is an industry highly vulnerable to harmful effects of climate change. It is also an industry susceptible to the positive influences of that change, at least in the medium term, and depending on a country's location and other key variables. Many countries, for example, near the equator, who receive less rain and have rocketing heat stress, are seeing crop and livestock productivity decline. Whereas countries farther north or south, that are receiving more rainfall and experiencing longer growing seasons are likely already reaping benefits of improved productivity.

MANY COUNTRIES HAVE ALREADY BEGUN TO FAMILIARIZE THEMSELVES WITH THEIR OWN VULNERABILITIES ON THE BASIS OF LONGER TIME SCALES, THEY MAY WELL BE SURPRISED WHEN VIEWING THAT VULNERABILITY ON A MUCH SHORTER TIME HORIZON

In all cases, the possible negative and positive effects are weighed together and given an impact level, either negative or positive. A vulnerability factor is then derived for each impact area based on the relative level of impacts ascertained for different countries. The factors themselves are created via a statistical normalization.

Higher factors of vulnerability are further away from the value where no harmful climate effect at all is perceptible. A factor of Acute + generally equates to three orders removed -- or mean average deviations -- from the baseline of no climate impacts.[12] A factor of Low means no perceptible vulnerability to the negative impacts of climate change. But many countries with a factor of Low vulnerability may well be reaping net benefits in certain areas. The degree of benefits is not recognized by the vulnerability factor, because from the moment impacts are neutral or positive they are no longer a vulnerability concern. Impact levels across the different indicators -- be they additional deaths or otherwise -- are given at the global and regional level and at national levels in various points, in particular in the country profiles also found in this report.

Countries with higher vulnerability factors do exhibit higher levels of impacts and typically require correspondingly greater attention in order to reduce those impacts. A country with a factor of Low will typically require no measures, since no negative effects are registered. A country with a factor of Moderate will typically require that certain measures be taken in order not to receive a negative impact. A factor of Acute may require many more times the scale of measures in order to prevent orders

THE UNITED STATES, FOR EXAMPLE, REGISTERS SIMILAR VULNERABILITY LEVELS TO GABON OR TONGA, DESPITE FUNDAMENTALLY DIFFERENT DEGREES OF CAPACITY AVAILABLE FOR CONFRONTING THESE VULNERABILITIES

of magnitude of impacts several times higher than for lower factors of vulnerability. Any country with a factor above Moderate is dealing with an unacceptable level of vulnerability, since cost-effective measures exist to reduce negative climate impacts and therefore minimize the vulnerability also.

Cost-effective measures are listed in the Adaptation Performance Review in this report and give an idea of the relationship between preventative investments and the losses indicated in the Monitor, which they aim to minimize. Measures aimed at reducing loss of life due to health impacts of climate change are particularly cost effective. Measures aimed at reducing impacts to human habitats and economic stresses are, on average, more costly to implement but still carry high benefits in many cases.

UNCERTAINTY AND RESPONSE

The accuracy of the Monitor does have its limitations. Estimates of impacts can be higher or lower, and the figures included here should be considered a robust set of possible outcomes around which planning and responses can be developed. Given clear indications of danger, responses cannot be delayed any longer because of an absence of complete scientific certainty.

In reality, these uncertainties mean, for example, that a country could easily have one full factor of vulnerability higher or lower than stated here. So a country with a factor of Severe could quite possibly have either a factor of Acute or High. That would be well within the margins of error involved in this work. While the Monitor bases itself to the extent possible on recent historical records of impact, all 2010 and 2030 values are estimates.

Within the uncertainty however, it is very unlikely that a country with a factor of Acute or Severe could in reality have a factor of Moderate or Low. Countries should, therefore, at a minimum be prepared for a level of impact corresponding to its assigned factor. But prudent planning would dictate a response commensurate to one factor higher than that assigned here, particularly if there is a probability of lives being at stake. Countries with the highest factor of Acute require special attention, since they most likely exceed by far any acceptable level of vulnerability and will necessitate correspondingly extreme measures in order to minimize harm done.

ANY COUNTRY WITH A FACTOR ABOVE MODERATE IS DEALING WITH AN UNACCEPTABLE LEVEL OF VULNERABILITY, SINCE COST-EFFECTIVE MEASURES EXIST TO REDUCE NEGATIVE CLIMATE IMPACTS

In the different impact areas, for the factors of High, Severe, and Acute we have also used two sub-factors "+" or "-", so, for example, "Acute+" or "Acute-". This indicates whether a country is in the first/bottom or second/top half within a given factor. "+" factors are more likely to fall into a higher category than "-" factors, and vice versa. Since the Monitor's focus is to offer guidance on the countries that are facing serious impacts, Moderate and Low vulnerability factors have not been given sub-factors.

The Methodology section in the end matter of this report provides a fuller explanation of all aspects of the Monitor and its many indicators.

LIMITATIONS

Aside from basic uncertainties, limitations are evident in a number of other respects. For one, climate and nation state rarely match up. Desertification or sea-level rise may only be felt in one small part of a country. Or some highland areas could benefit from longer growing seasons or more rainfall, while other parts of a country are scorched or parched. These effects are, of course, averaged across the Monitor, which uses countries as its unit of analysis because of data availability (health statistics, for instance, are mainly national) and because governments are expected to lead much of the response to climate change. However, the nation-state unit of analysis should not detract from the Monitor's insistence on people and communities as an

THE NATION-STATE UNIT OF ANALYSIS SHOULD NOT DETRACT FROM THE MONITOR'S INSISTENCE ON PEOPLE AND COMMUNITIES AS AN ORGANIZING CONCEPT

organizing concept that takes its cue from the 2009 Global Humanitarian Forum publication, The Anatomy of A Silent Crisis, which strongly articulated the underappreciated human dimensions of climate change and vulnerability to it.[13]

In many cases, such as for extreme weather, this report relies on estimates based on observational increases in storms or floods. But a five-percent increase in weather may be all the difference between a disaster and none at all -- if, for example, the capacity of a community to withstand the impact is overwhelmed by the seemingly small additional increase. In the areas of extreme weather, fisheries, and other fields not included here, such as infection rates for key climate-sensitive diseases, there is yet to be any sound scientific attribution quantifying a possible aggravating effect due to climate change. Despite the difficulties of establishing detailed climate role attributions, these are nevertheless vital to the development of any sound responses to possible impacts and are urgent research demands requiring much greater attention.

A number of decisions have been made to exclude indicators so that assessment of vulnerability is as consistent as possible from one country to another. Indications of mortality due to health problems or extreme weather are relied on, for example, but rates of infection, people in need of assistance ("affected"), people displaced, and people injured are not. Reporting of the excluded indicators varies widely around the world and might lead to underestimating the comparative vulnerability of some countries. But mortality only gives a proxy for the true extent of the health impact, where tens of thousands of people might be infected. Likewise, the number of deaths due to a storm or flood give no clear indication of how many people – sometimes millions – might be in need of assistance or temporary or permanent housing.

In the same way, since the Monitor gives scales of impacts averaged over the course of one year, it does not provide an idea of how a large problem might have been in a very short space of time. This is less of a problem when we look at generalized economic stresses, losses in human habitat, or certain health effects. The numbers could be quite misleading with respect to extreme weather, when many years worth of impacts could occur in less than 24 hours. Or impacts that the Monitor provides as averages per year may not even occur in a given country during one year or even several years. For this reason, a series of Peak Impacts are given within each of the main Monitor impact area sections. While there is no clear indication or inference that these events are attributable to climate change to any degree, they do provide an indication of how severe some climate-related phenomenon can become.

While the impact areas included in the Monitor were chosen for their ability to capture a wide picture of vulnerability. Many effects have not been touched on here, primarily because little research was available to draw upon in order to quantify a meaningful relationship with climate change. Impacts on sectors of the economy other than agriculture, for example, such as the tourism or transportation industries, have not been taken into account. Climate-related displacement or migration is only dealt with indirectly in relation to sea-level rise and desertification. Conflict and security issues are not touched on at all because of the very preliminary nature of that debate, despite the fact that almost all ongoing conflicts are occurring in countries highly vulnerable to climate change, and the fact that fragile states dominate the ranks of the most vulnerable.[14] A more detailed account of research gaps that affect the accuracy and breadth of this report and the Monitor is included in the end matter. It is primarily for this reason that we believe the Monitor most likely underestimates the scale of the impact of climate change on human society.

The chosen data can also be an issue. Venezuela, for example, registers 30,000 deaths in the main global disaster database for the 1999 Vargas flood tragedy. But a recent study estimates that the death toll could not have been more than 700. Since the Monitor assumes past scales of impact can provide one facet of an indication of future scales of impact, where climate change will play a small aggravating role, such a discrepancy would artificially inflate the climate vulnerability of a country.

Finally, the climate models used to support the Monitor have been chosen for close comparability, but not all follow precisely the same future emissions or climate scenario and the base years used by models also varies. Some of these issues are minimized by the fact that the Monitor only assesses vulnerability for 2010 and 2030. On longer time horizons, different emission and climate scenarios could have wildly dissimilar results.

MANY YEARS WORTH OF IMPACTS COULD OCCUR IN LESS THAN 24 HOURS

TOWARDS COMPREHENSIVE RESPONSES

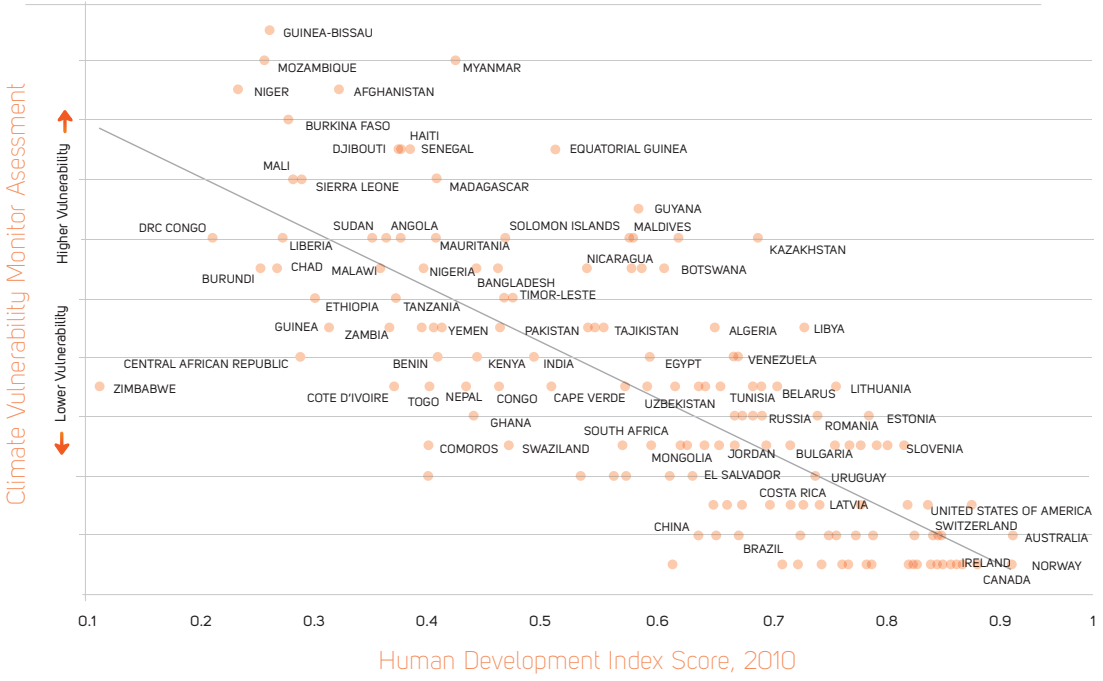
While this report's Adaptation Performance Review provides a good overview of some of the key actions that can be taken to reduce impacts identified in the Monitor, the non-exhaustive catalogue of actions covered in the Review are only one aspect of a much broader response that is necessary to tackle the impact of climate change.

Indeed, since many of the most vulnerable countries are also suffering from extreme poverty and weak state institutions, a good number of the actions assessed in the Review may be very difficult to implement if wider political, structural, and socio-economic concerns are not also addressed. So reducing vulnerabilities implies reinforcing socio-economic development, promoting gender equality, promoting strong political, legal, and institutional governance as well as effective public services, and, in particular, working to achieve the Millennium Development Goals -- the most internationally recognized objectives in the fight against poverty.

Chief among the known drivers of climate vulnerability are poverty, governance, and gender development, as outlined in the 2007/08 UNDP *Human Development Report*.[15] From this starting point, some preliminary analysis has been conducted comparing the Monitor's findings with three well-recognized indices of headline climate vulnerability drivers: the Human Development Index, the Gender Inequality Index, and, most recently, the Multi-Dimensional Poverty Index.[16]

CLIMATE VULNERABILITY AND HUMAN DEVELOPMENT

Correlation between the climate vulnerability monitor assessment and human development index score

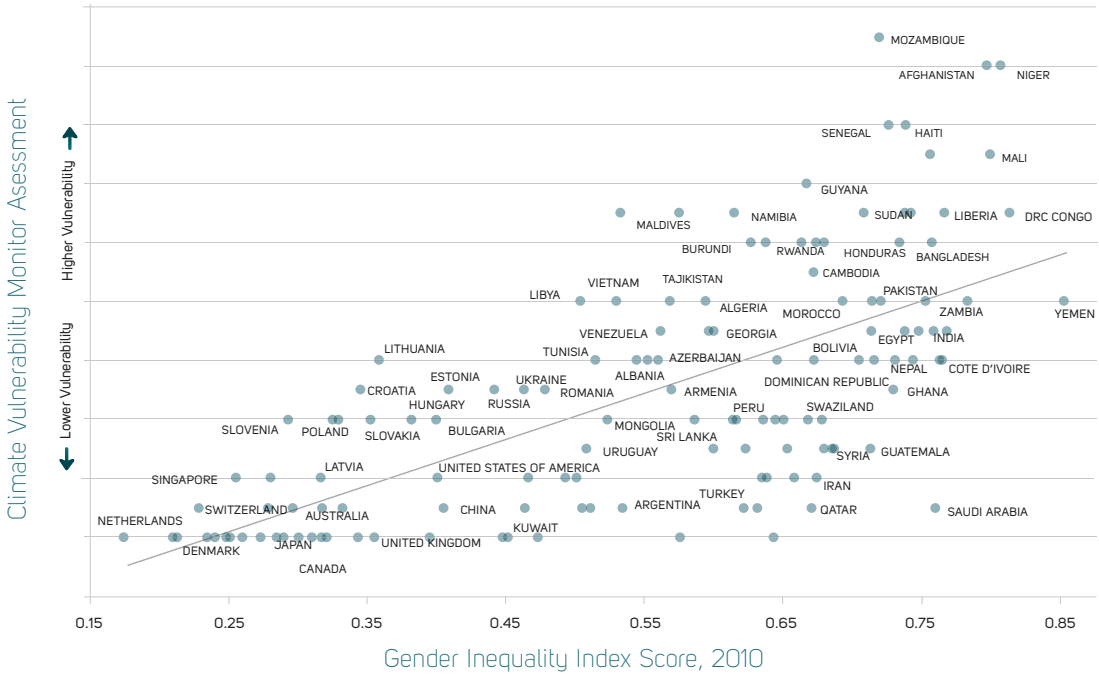


Each of these indices demonstrates a strong relationship with the Monitor. The most pronounced is the apparent link between the Human Development Index and the Monitor, whereby human development steadily decreases with every factor increase in climate vulnerability. Gender inequality and multi-dimensional poverty also increase together with rising climate vulnerability. So climate-vulnerable countries are more likely to have high levels of gender inequality

or poverty. Gender development is particularly important for human health impacts of climate change, which disproportionately affect children in developing countries, who are most likely cared for by their mothers or other female family members or friends.[17] However, women have a role to play across all aspects of the Monitor, given their recognized positive contributions to enhancing democratic governance, education, and disaster risk reduction work, as well as to economic prosperity and social cohesion.[18]

CLIMATE VULNERABILITY AND GENDER INEQUALITY

Correlation between the climate vulnerability monitor assessment and gender inequality index score



Outside of these strong correlations, there are a number of countries, for example, of comparative human development with significantly higher or lower climate vulnerability than the norm. This defies rigid adhesion to the idea that low human development equates in exactly equal measures to climate vulnerability. Higher climate vulnerability than that of countries with similar levels of human development in general implies greater exposure to changing weather or environmental conditions linked to climate change. For reasons of geography alone, not all poor or less-developed countries are exposed to the same degrees of climate stress.

This information can help identify how we can best apply socio-economic strategies to reduce systemic vulnerabilities. For example, Equatorial Guinea, the Maldives, Myanmar, and Vanuatu are all affected well beyond other countries with similar levels of socio-economic development. These countries require special attention if prosperity is to be upheld in the face of growing climate impacts that each is already feeling disproportionately compared with similarly developed countries.

FOR REASONS OF GEOGRAPHY ALONE, NOT ALL POOR OR LESS-DEVELOPED COUNTRIES ARE EXPOSED TO THE SAME DEGREES OF CLIMATE STRESS

ACUTE
Mean country 2010/2030: Burkina Faso/Nigeria

# COUNTRIES: 54			AVERAGE HUMAN DEVELOPMENT	0.37 - Low
IMPACT AREA	**2010**	**2030**	**AVERAGE COUNTRY IMPACT (ABSOLUTE/2030)**	
OVERALL	15	54	MORTALITY – CLIMATE SENSITIVE DISEASES	17,000 deaths/year
HEALTH IMPACT	22	42	MORTALITY – EXTREME WEATHER	200 deaths/year
WEATHER DISASTERS	12	20	POPULATIONS AT RISK – DESERTIFICATION	220,000 people
HABITAT LOSS	22	48	SEA-LEVEL RISE COSTS (USD PPP)	900 million dollars/year
ECONOMIC STRESS	28	68	OTHER SECTOR/ASSET COSTS/ LOSSES (USD PPP)	1.2 billion dollars/year

Acute countries comprise the most vulnerable category. Impacts registered are far beyond the global norm. Acute countries are experiencing large proportions of the overall global impacts due to climate change. Any country with a factor of Acute in just one area could be facing damages of great significance. However, many Acute countries are already facing serious challenges of human development, the rule of law and social and gender inequalities. Handfuls of countries are assessed as Acute. However, unless actions are taken to counteract the negative effects of climate change, by 2030 this category will explode some two-fold.

SEVERE
Mean country 2010/2030: Bhutan/Côte D'Ivoire

# COUNTRIES: 28			AVERAGE HUMAN DEVELOPMENT	0.47 - Low
IMPACT AREA	**2010**	**2030**	**AVERAGE COUNTRY IMPACT (ABSOLUTE/2030)**	
OVERALL	31	28	MORTALITY – CLIMATE SENSITIVE DISEASES	4,000 deaths/year
HEALTH IMPACT	25	20	MORTALITY – EXTREME WEATHER	80 deaths/year
WEATHER DISASTERS	8	14	POPULATIONS AT RISK – DESERTIFICATION	25,000 people
HABITAT LOSS	11	19	SEA-LEVEL RISE COSTS (USD PPP)	450 million dollars/year
ECONOMIC STRESS	49	38	OTHER SECTOR/ASSET COSTS/ LOSSES (USD PPP)	650 million dollars/year

Severe countries are the second most vulnerable category. Impacts registered are well above the global norm. Severe countries contribute significantly to overall global impacts due to climate change, especially in 2010. Given the limitations of the methodology of the Monitor, any country with a factor of Severe could in reality have a profile of Acute. Severe countries are facing challenges that would place heavy additional stress in any given impact area. The majority of Severe countries will become Acute by 2030 unless action is taken to counteract the growing impact on these countries.

HIGH
Mean country 2010/2030: Cameroon/Macedonia

# COUNTRIES: 50			AVERAGE HUMAN DEVELOPMENT	0.58 - Medium
IMPACT AREA	**2010**	**2030**	**AVERAGE COUNTRY IMPACT (ABSOLUTE/2030)**	
OVERALL	51	50	MORTALITY – CLIMATE SENSITIVE DISEASES	1,000 deaths/year
HEALTH IMPACT	36	46	MORTALITY – EXTREME WEATHER	40 deaths/year
WEATHER DISASTERS	37	36	POPULATIONS AT RISK – DESERTIFICATION	8,000 people
HABITAT LOSS	47	25	SEA-LEVEL RISE COSTS (USD PPP)	400 million dollars/year
ECONOMIC STRESS	64	59	OTHER SECTOR/ASSET COSTS/ LOSSES (USD PPP)	1.7 billion dollars/year

High countries are the third most vulnerable category. Impacts registered are above the global norm by a degree of some significance. High countries are especially remarkable for their strong contribution to overall economic losses, due to the large number of emerging and highly developed countries in the category, especially as expected for 2030. Given the limitations of the methodology of the Monitor, any country with a factor of High could in reality have a profile of Severe or Moderate. High remains a stable category between 2010 and 2030, since many High countries will graduate to a factor of Severe by 2030, and many Moderate countries will likewise have a vulnerability profile equating to a factor of High by that same time.

MODERATE

Mean country 2010/2030: Sri Lanka/Australia

# COUNTRIES: 33			AVERAGE HUMAN DEVELOPMENT	0.72 - High
IMPACT AREA	**2010**	**2030**	**AVERAGE COUNTRY IMPACT (ABSOLUTE/2030)**	
OVERALL	61	33	MORTALITY – CLIMATE SENSITIVE DISEASES	300 deaths/year
HEALTH IMPACT	92	33	MORTALITY – EXTREME WEATHER	25 deaths/year
WEATHER DISASTERS	127	114	POPULATIONS AT RISK – DESERTIFICATION	Nil
HABITAT LOSS	82	69	SEA-LEVEL RISE COSTS (USD PPP)	275 million dollars/year
ECONOMIC STRESS	39	13	OTHER SECTOR/ASSET COSTS/ LOSSES (USD PPP)	450 million dollars/year

Moderate countries are the first real vulnerability category, since Low countries are expected to experience little negative impacts or even positive benefits as a result of short-term climate change. Impacts registered are only more or less at the global norm, hence the large numbers of countries in this category. Due to the limitations of the Monitor's methodology Moderate countries could easily also be either High or Low. In general, Moderate countries are not heavily impacted in more than one area as a result of climate change. Although many Moderate countries will progress in their vulnerability to High by 2030.

LOW

Mean country 2010/2030: France/Japan

# COUNTRIES: 19			AVERAGE HUMAN DEVELOPMENT	0.84 - Very High
IMPACT AREA	**2010**	**2030**	**AVERAGE COUNTRY IMPACT (ABSOLUTE/2030)**	
OVERALL	26	19	MORTALITY – CLIMATE SENSITIVE DISEASES	Nil
HEALTH IMPACT	9	50	MORTALITY – EXTREME WEATHER	Nil
WEATHER DISASTERS	Nil	Nil	POPULATIONS AT RISK – DESERTIFICATION	Nil
HABITAT LOSS	22	23	SEA-LEVEL RISE COSTS (USD PPP)	750 million dollars/year
ECONOMIC STRESS	4	6	OTHER SECTOR/ASSET COSTS/ LOSSES (USD PPP)	(5 billion)* dollars/year

Low countries register no vulnerability due to climate change or even positive benefits in some areas. The only area where countries with a factor of Low vulnerability register any impacts as a result of climate change is in the area of sea-level rise, where impacts will be felt, at least to a small degree, anywhere there is a coastline. Due to the limitations of the Monitor's methodology Low countries could easily also be Moderate, although it is extremely unlikely that countries with a factor of Low would have anything more than Moderate of High vulnerability to climate change in reality. There is a surge of countries with a factor of Low vulnerability in the impact area or health through to 2030, due to the increasing health benefits due to warmer weather, and shorter, warmer winters in higher latitude countries by this time. Otherwise the category is generally static, with most of the category Low countries retaining their vulnerability status over the next 20 years, due mainly to extremely high average levels of human development.

*Parentheses/brackets indicate a net gain in economic terms for Low factor countries in 2030

PEAK IMPACT

Peak Impact gives an idea of how large some disasters linked to climate change can be. The numbers provided by the Climate Vulnerability Monitor are often annualized averages of possible impacts based on historical or actual statistics. However, many countries are only hit once in a decade, with potentially all the impact falling in just one day or one month. It should not be inferred that climate change is fully responsible for any of the events referred to in the Peak Impact series in this report. Although the additional stress of climate change may in particular be responsible for triggering large disasters that occur especially when the usual levels of impact familiar to populations are exceeded. Peak Impacts provide an example of the types of extremes already experienced across different impact areas around the world since the year 1997.

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

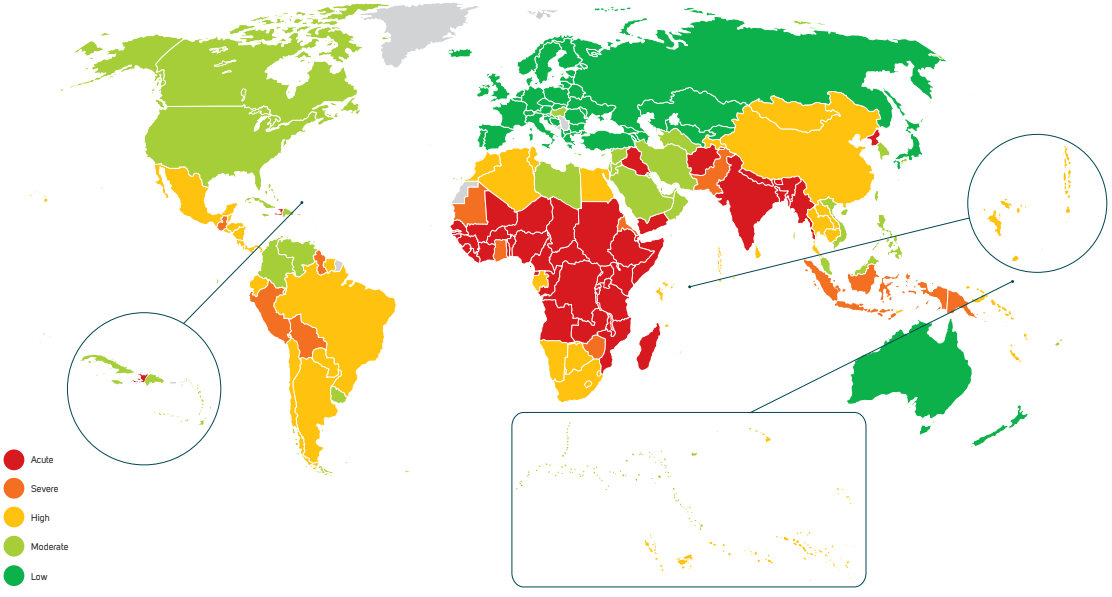
FINDINGS

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 overal climate vulnerability for health

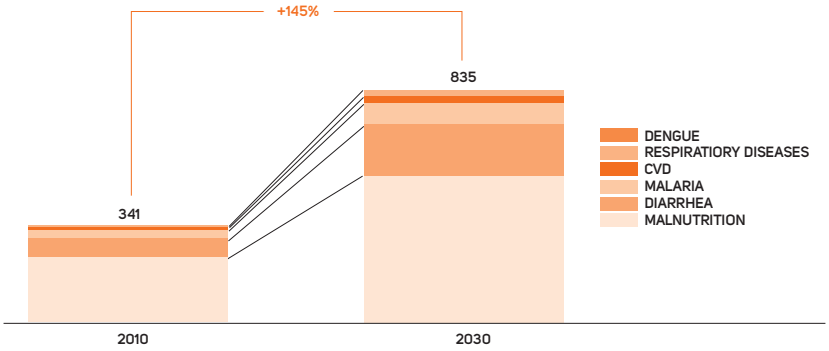


By far the majority of climate change-related deaths are due to malnutrition, diarrhea and malaria. These are already three of the greatest causes of avoidable deaths around the world, particularly in the poorest countries.[19] Climate change contributes to around 230,000 of the more than 3 million deaths 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



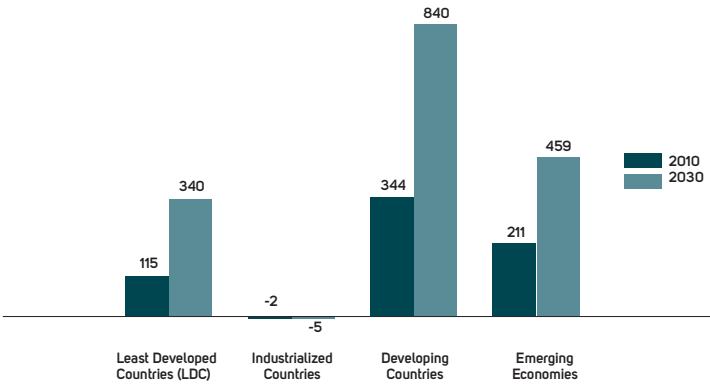
This progression is based on projections of increasing temperatures and other climate-related stresses over the next 20 years. It also incorporates population growth projections.

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.[20] 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.[21]

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

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*.[23]

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.[24]

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.[25]

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[26]
2004	Indonesia	Dengue Fever	Over 58,000 infected, 658 deaths[27]
2006	India (northeast)	Malaria	25,000 infected, 50 died[28]
2008-2009	Zimbabwe	Cholera	98,741 infected and 4,293 deaths. Deadliest African cholera outbreak in the last 15 years[29]
2009	Bolivia	Dengue Fever	31,000 infected. A national emergency was declared[30]
2010	Haiti	Cholera	Death toll estimated at 442 as of November 2010 - first verified outbreak in the country[31]

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

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.[32] Heat waves, of course, are expected to be more common in many areas as a result of climate change.[33] 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.[34]

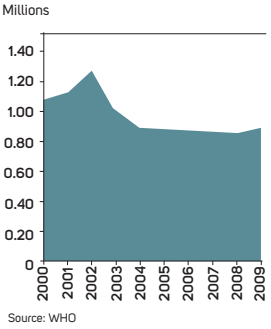
Insects such as mosquitoes breed faster in such conditions and can thereby spread illnesses more widely. Temperature may also accelerate the rate at which vectors (such as mosquitoes) replicate diseases within their bodies, so they become infectious faster and spread diseases faster.[35] In the most 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.[36] The burden of vector-borne diseases will likely also spread to higher altitudes as mountainous zones warm up.[37] 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.[38] The number of days or months of exposure are also expected to increase.[39] Yellow fever, not covered here, could react similarly to dengue and malaria.[40]

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

OVERALL DEATHS FROM MALARIA



Source: WHO

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.[41] Warming waters in coastal areas also favour the development of cholera bacteria.[42] The diarrhea 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.[43]

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_2 on which plants feed, for instance, are unlikely to be realizable in practice.[45] Livestock will also suffer declines in many instances, since the grass or feed they are raised with is under stress too.[46] 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.[47]

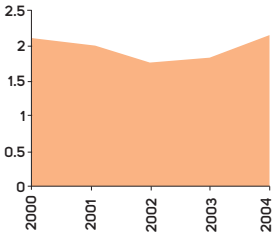
While some regions will benefit from short- to medium-term improvements in agriculture, across fisheries, crops, and livestock, the global availability of food will be under increased stress due not only to climate factors, but also in large part to population growth and increasing demand.[48] And the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

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

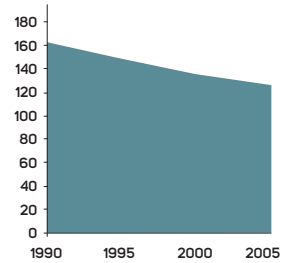
Millions



Source: WHO

UNDERWEIGHT PREVALENCE

Millions preschool children



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

There is some evidence of a decreasing prevalance in overall global malnutrition rates in recent times, mainly due to sustained economic development and improved programmes combating this deadly health concern.[44] 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
• Changes in temperature • Changes in local rainfall	• Droughts • Increasing water pressure • Reduced crop yields	• Food security: Hunger / nutritional status • Lower respiratory infections	Impact of malnutrition • Described as deaths related to malnutrition and lower respiratory infection due to climate change
• Changes in local rainfall and river run-off patterns • [Melting glaciers]	• Increasing water pressure • Inland floods • Coastal floods	• Diarrhea • Access to clean drinking water • Access to basic sanitation • Water-borne diseases	Impact of diarrhea • Described as deaths related to diarrhea due to climate change
• Changes in temperature • Changes in local rainfall	• Changes in environmental conditions for disease vectors • Floods / standing water	• Expansion of disease-endemic zones for vector-borne diseases • Increased transmission of malaria and other vector-borne diseases	Impact of vector-borne diseases • Described as deaths related to malaria and dengue due to climate change
• Extreme thermal exposures	• More frequent extreme temperature events (heat and cold)	• Stroke • Asthma	Impact of extreme heat events • Described as deaths related to cardio-vascular diseases and respiratory diseases due to climate change

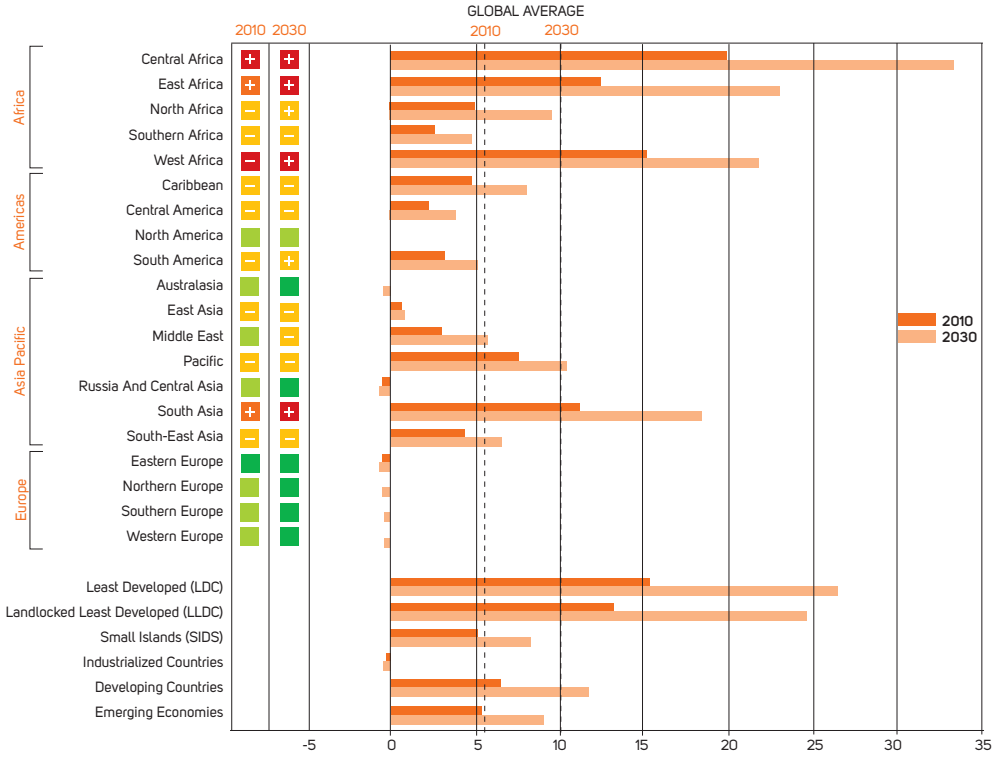
WHO SUFFERS?

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.[50] 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.[51] 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.

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.[52]

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)

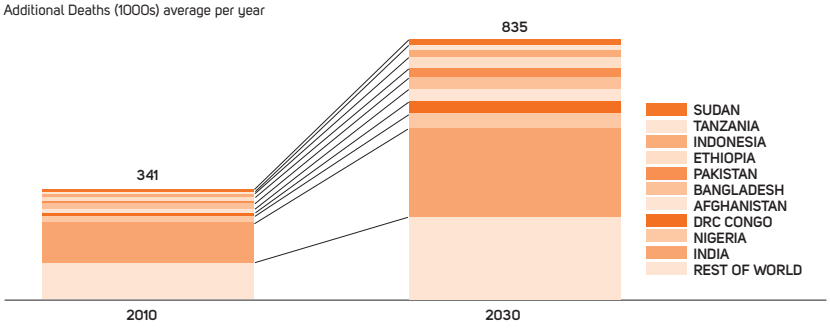
The top 10 countries worst and least affected countries by the health impacts of climate change in 2030 relative to their size

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

HOTSPOTS: MORTALITY

Countries with the largest total climate-related health impact by number of deaths

Additional Deaths (1000s) average per year



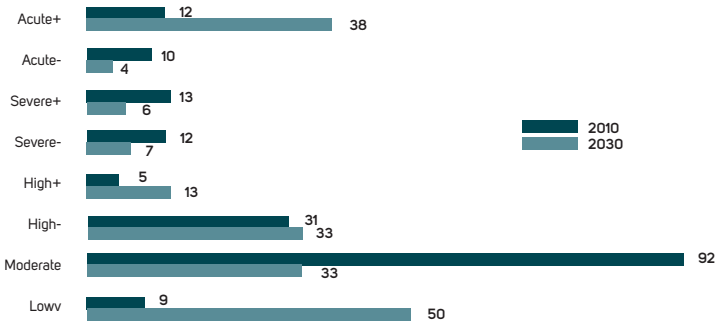
THE IMPACT TOMORROW: 2030

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



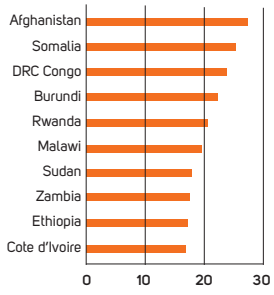
Almost every Sub-Saharan African region will become acutely vulnerable to climate change by 2030. This will also be the case for South Asia.

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.[53] 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.[54]

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.[55]

Climate change is therefore estimated by the WHO to cause roughly 3.5% of the burden of diarrhea in many countries.[56] 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.[57] 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.[58] 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.[59] 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.[60]

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.[61] 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.[62]

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

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.

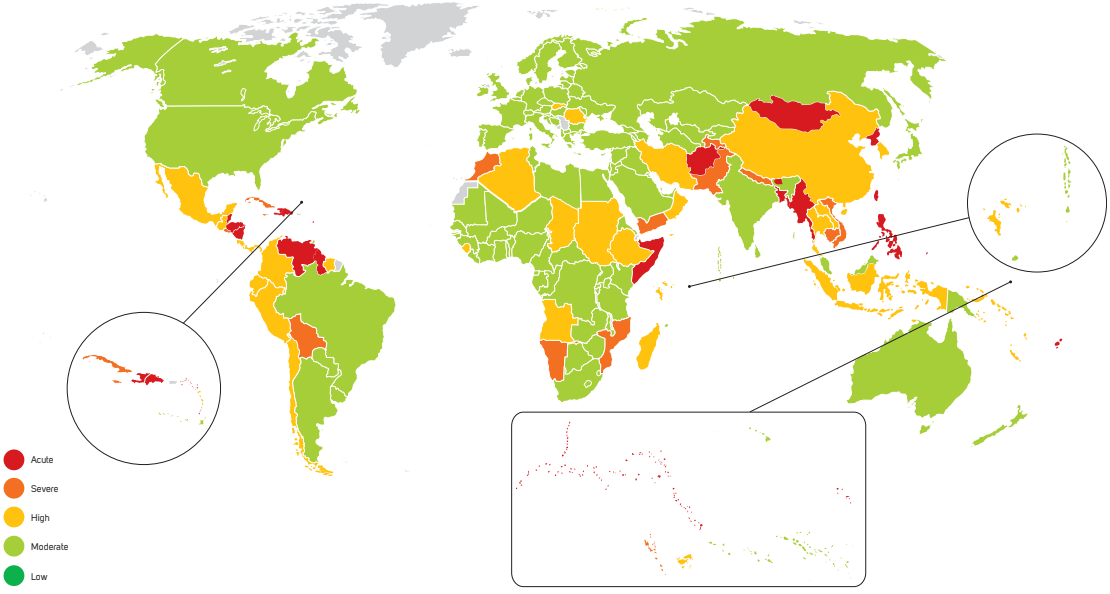
2010
CLIMATE EFFECT TODAY
3,500 DEATHS PER YEAR
4.5 BILLION DOLLAR IMPACT PER YEAR

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.

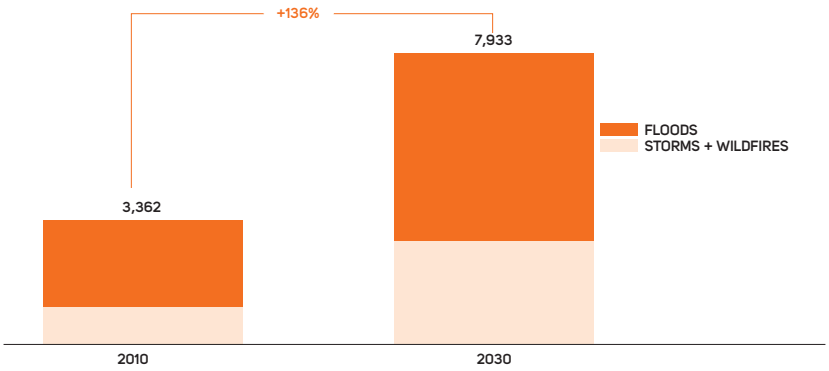
Floods, storms, and wildfires have claimed an average of 27,000 lives every year over the past 20 years.[64] Climate change is already estimated to contribute over 3,000 deaths to that toll each year. By 2030, climate change is projected to be responsible for over 7,000 such deaths if measures are not 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 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.

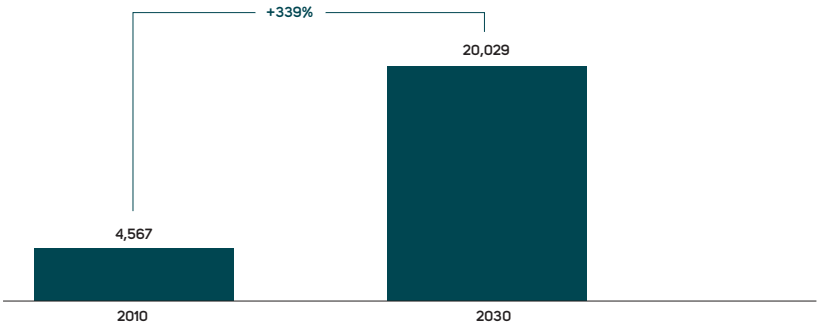
IMPACT DYNAMICS

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 ▲

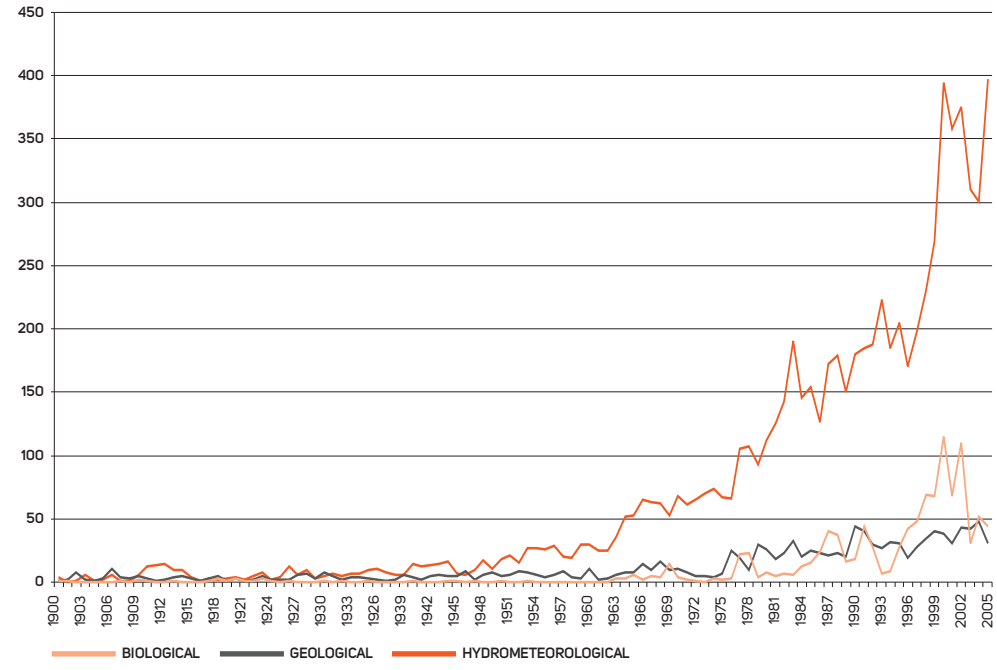
1998	Central America	Hurricane Mitch	18,811 deaths, more than 3 million affected-over $6 billion in damages[67]
2005	United States	Hurricane Katrina	1,833 deaths, 500,000 affected- $125 billion in damages[68]
2007	Bangladesh	Cyclone Sidr	4,234 deaths, 6 million left homeless - $2.3 billion in damages 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: IDSR/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

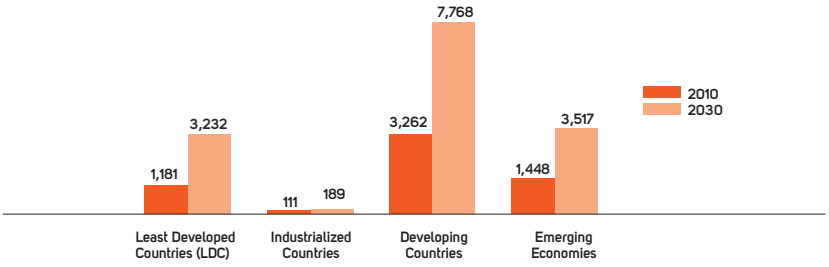
WHO SUFFERS?

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

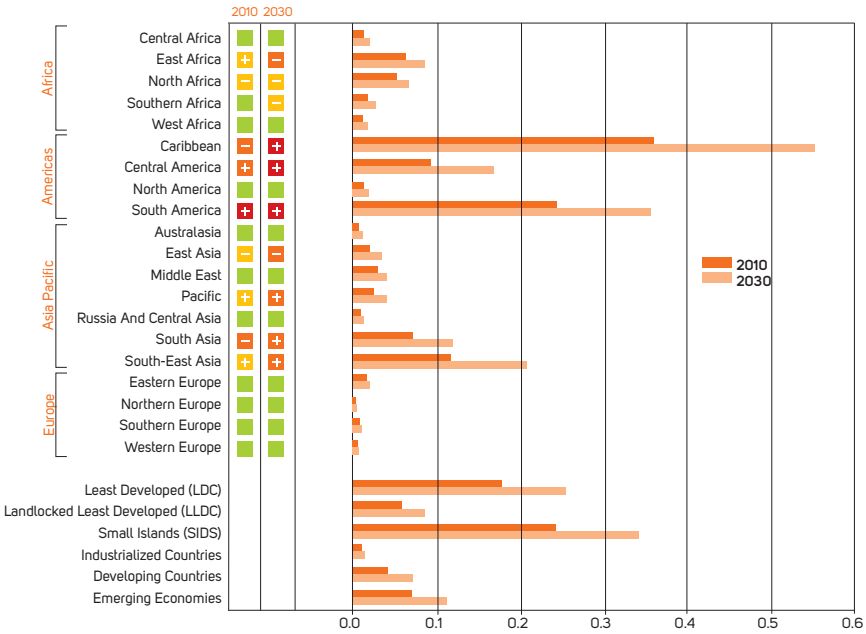
Additional Deaths average per year



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.

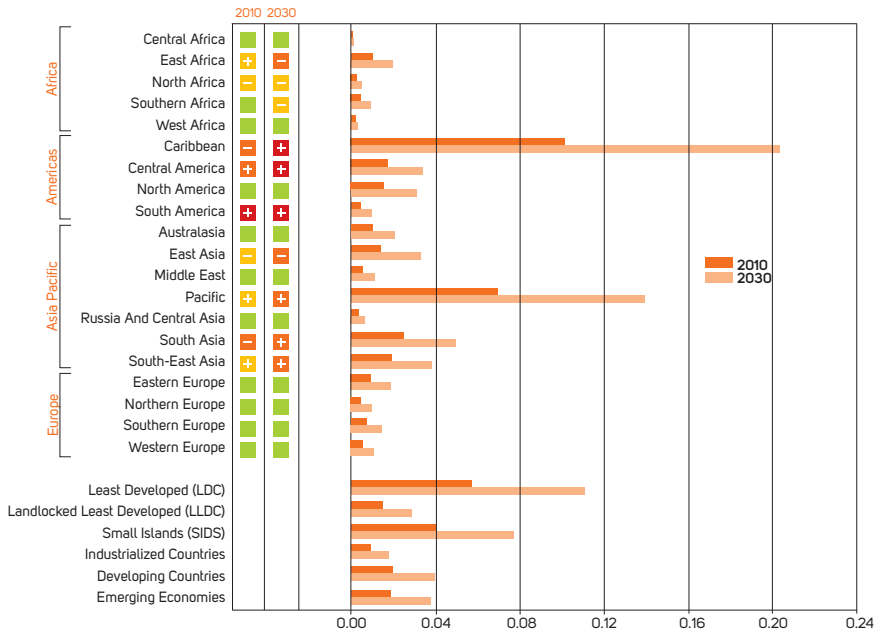
IMPACTS AROUND THE WORLD: MORTALITY

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)



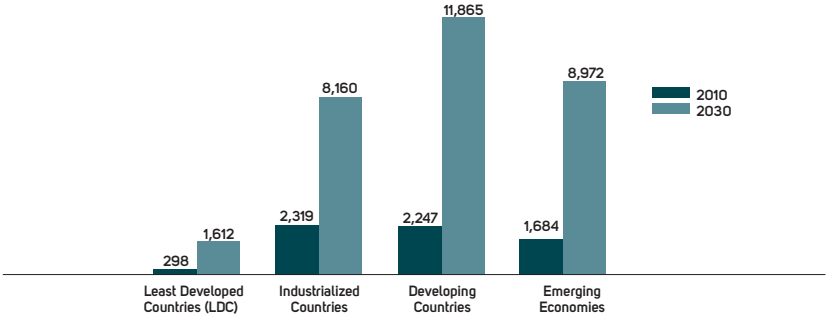
Venezuela tops the list of the worst-impacted countries. Venezuela has faced debilitating disasters over the past 20 years. However, it's possible that observations reported in the database used for the Monitor may exaggerate 1999 flood impacts in Venezuela by an order of magnitude.[92]

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.

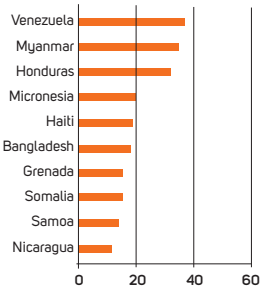
Although neither is the past necessarily the best indication of what is to come. But the Monitor, for example, does not highlight Cambodia, Vietnam, Philippines, and Fiji as highly vulnerable despite the fact that they lie in clear cyclone paths, since they have not registered high fatalities or damages 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



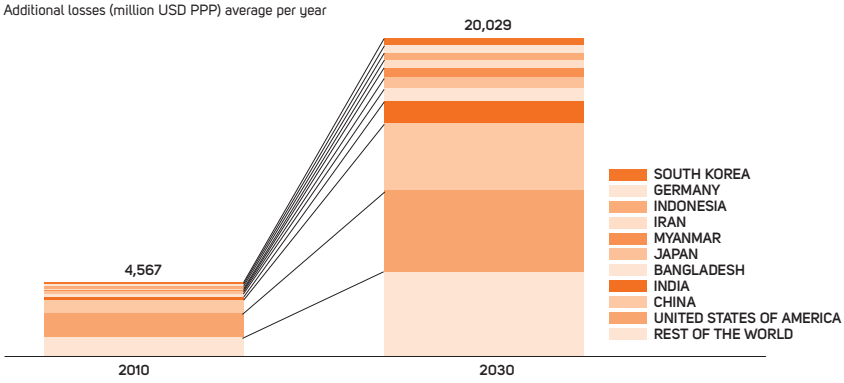
VULNERABILITY SHIFT

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 losses (million USD PPP) average per year



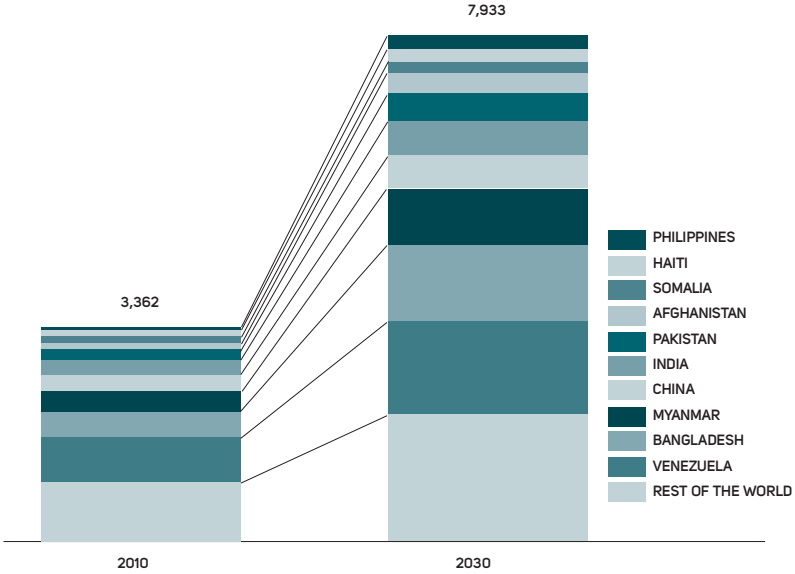
THE IMPACT TOMORROW: 2030

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]

HABITAT LOSS

The often irreversible loss of human habitat to deserts and rising sea-levels are among the most vivid effects of the change in our climate. Increasing temperatures contribute to rising sea-levels and cause deserts to expand.[109] When summed up globally, today's slow, nearly undetectable changes to seashores and advances of arid lands and deserts ultimately affect millions of people. And these changes are relentless and accelerating. The poorest communities often feel the worst impact of these effects. And worst hit among them are low-lying countries, such as small island developing states, nations with large river estuaries, and communities living in arid zones or drylands.[110]

2010

CLIMATE EFFECT TODAY

3 MILLION

AT RISK FROM DESERTIFICATION

65 BILLION DOLLAR

SEA-LEVEL RISE IMPACT PER YEAR

2030

CLIMATE EFFECT TOMORROW

10 MILLION

AT RISK FROM DESERTIFICATION

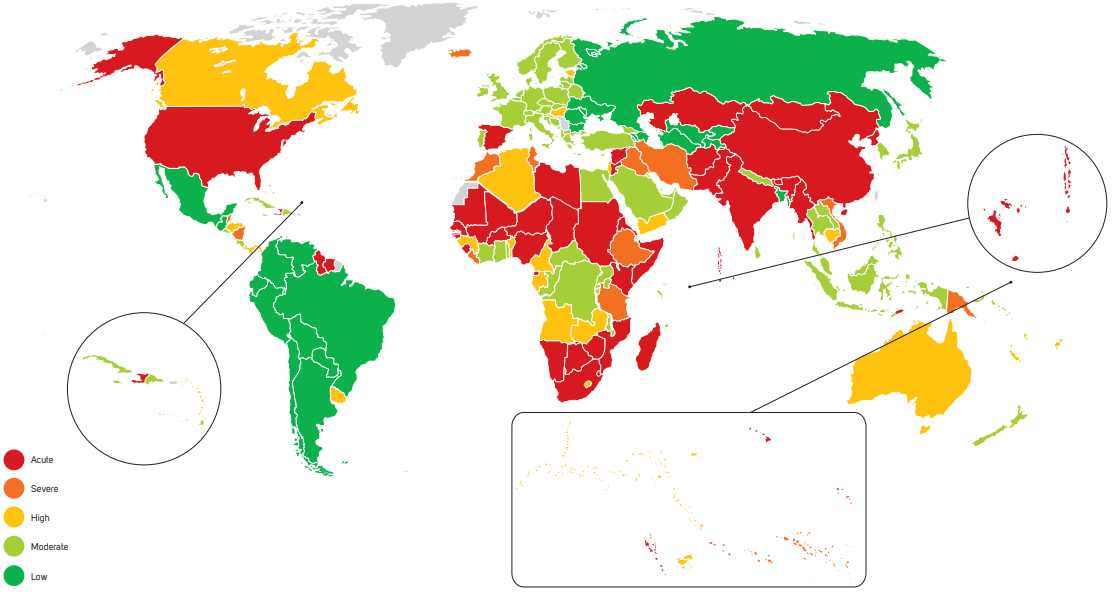
100 BILLION DOLLAR

SEA-LEVEL RISE IMPACT PER YEAR

FINDINGS

GLOBAL VULNERABILITY TO CLIMATE HABITAT LOSS

countries by overal climate vulnerability for habitat



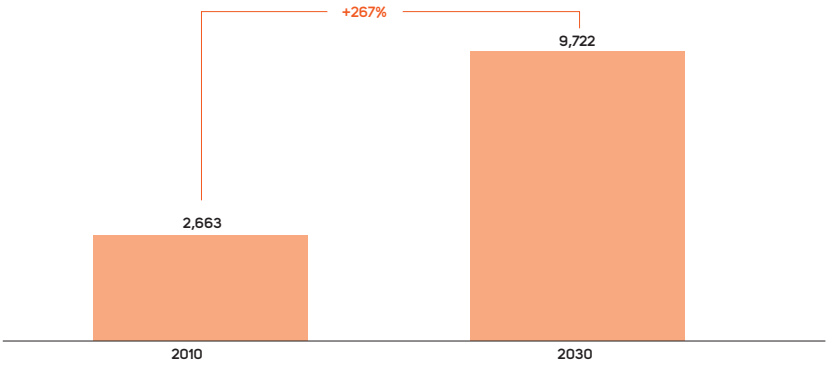
This chapter assesses the slow but devastating impact of climate change on environments where people live. The frontline of the struggle of people against damaged and vanishing lands is taking place at the borders of the world's growing deserts and on the shores of the world's rising seas.

Both desertification and sea-level rise are claiming land from people and passing on heavy costs to the communities affected. In the absence of significant countermeasures, more than 2 million people are estimated to be at risk of desertification due to climate change today. And that figure will rise to almost 10 million by 2030.

Climate change is the principal factor responsible for sea-level rise. The relentless stress caused by rising seas is systematically wearing down coastal areas and their communities in every part of the world.[111] Rising sea-levels are estimated to cause USD 65 billion in losses each year today, a figure expected to rise to almost USD 100 billion in losses each year by 2030 as coastal lands are quietly flooded, degraded, or completely submerged.

GLOBAL CLIMATE DESERTIFICATION IMPACT BURDEN

The change in the scale of global climate-related desertification population risks from 2010 to 2030
Total additional persons at risk of desertification (1000)

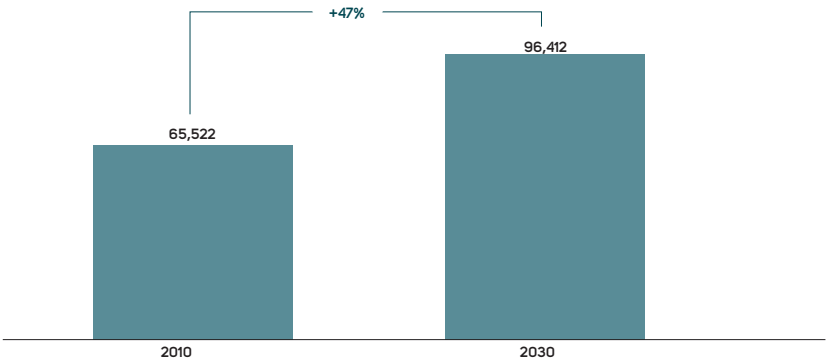


Developing countries are expected to experience the lion's share of these impacts. More than 80% of the impact of both desertification and sea-level rise is projected to hit developing countries through 2030. However, particularly in regards to sea-level rise, industrialized countries are also projected to face a significant burden in absolute terms.

Human habitats in two groups of countries are particularly vulnerable to the effects of climate change -- those in land-locked least developed countries (who face a dramatic threat of desertification) and those in small island developing states (who will be hit hard by the effects of sea-level rise).

GLOBAL CLIMATE SEA-LEVEL RISE IMPACT BURDEN

The change in the scale of global climate-related sea-level rise losses from 2010 to 2030
Additional losses (million USD PPP) average per year



Habitat loss here refers to human habitats. It refers to the loss of arable land due to desertification and to the loss of land for any human use as a result of sea-level rise. The serious effects of climate change on marine and other species will also impact human societies. We often use the term "habitat loss" to refer to these wider environmental concerns, but it should be noted that this report does not take the full scope of these concerns into account.

Climate change's role in desertification is quite different from its role in sea-level rise. Desertification is happening rapidly around the world. But climate is only one of many contributing factors to desertification. Overgrazing, over cultivation, exhaustion of local water resources, and deforestation are other serious drivers of the phenomenon.[112] Measures exist for stemming or even reversing desertification (such as soil conservation or reforestation) and protecting against sea-level rise (through heavy infrastructure such as sea walls). But such measures can be extremely costly per square km or mile of land saved or restored. The thought of protecting the world's 850,000 kms (550,000 miles) of coastline or the nearly 40% of the planet's land surface that are arid zones is almost overwhelming.[113] Focusing our efforts, however, could well mean relinquishing parts of the world's once habitable land for good.

IMPACT DYNAMICS

The scientific evidence for climate change and its key role in sea-level rise is well established.[114] The role of climate change in desertification is less well agreed upon due to the vast range of factors involved.[115] This chapter does not deal with the full range of human and animal habitats under threat, such as Arctic tundra lands, boreal forests, coral reefs, and tropical and temperate peat-lands. These are, however, covered to an extent in the Economic Stress section, where losses in biodiversity linked to climate pressures on these and other areas have been calculated in economic terms. Drought -- which is linked to desertification but is a separate climate phenomenon -- is covered in the health and economic sections of this report in relation to its impact on human health, agriculture, biodiversity, and water resources.

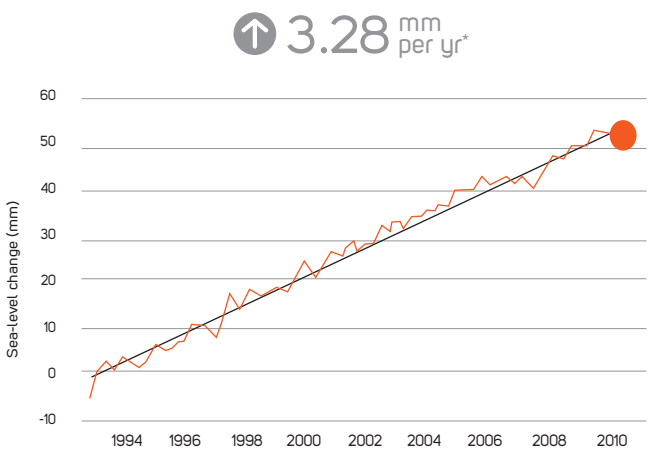
PEAK IMPACT HABITAT ▲

ONGOING	China- Gobi Desert	Desertification	Expanding at a rate of 3,600 km2 or 1,400 miles2 per year[116]
ONGOING	Sahel	Desertification	Expanding at the rate of 25 km2 or 9 miles2 per year[117]
1997	Tuvalu	Sea-level Rise/ Storm Surge	Cyclone destroyed an islet rendering it uninhabitable[118]
1999	Kiribati	Sea-level Rise	Lost two islets which disappeared underwater[119]
2008	Marshall Islands	Storm surge/ coastal flooding/ sea-level rise	Storm surge combined with high tides caused severe flooding. 10% of population was evacuated[120]
2008	Papua New Guinea	High Seas/ Coastal Flooding	75,000 affected in low-lying islands and coastal regions in 7 provinces[121]
2010	Bangladesh (Sunderbans)	Sea-level rise	South Talpatti, which was 210 km2 or 80 miles2, became the 5th island in the Sunderbans to sink[122]
2010	Thailand (Andaman Sea)	Coral bleaching event	Largest coral bleaching witnessed since 1998 - 95% of coral bleached[123]

SEA-LEVEL RISE

The world's seas have risen by 3.3mm (1/8 inch) every year over the last 15 years.[124] That amounts to one centimetre (just under a 1/2 inch) every three years, or 3-4 cm (1 inch) a decade. Over the course of the 20th century, sea-levels rose by around 20 cm. This century they will continue to rise faster still.[125]

RATE OF GLOBAL AVERAGE SEA-LEVEL RISE
Satellite sea-level observations



* estimate for 1993-2010
Source: NASA CLS/Cnes/Legos"

Sea-level rise is caused by two factors: Thermal expansion of warming water and fresh water influx due to melting land ice. The latter is estimated to be gaining momentum due to rising temperatures. Observations of the Greenland and Atarctica ice sheets indicate they are increasingly losing mass, and mountain glaciers are melting at an accelerated pace, according to observations. Estimates for the last five years indicate an 80% land-ice contribution to the observed global sea-level rise.[126] Both factors will continue to be affected and aggravated by rising temperatures even after global temperatures have stabilized, which means that sea-levels will continue to rise for many centuries.[127]

With rising temperatures, large ice masses become more vulnerable. Their potential contribution to sea-level rise is enormous. The Greenland ice sheet holds enough water to raise the global sea-level by up to 7 meters (23 feet). There is, however, currently no evidence from model simulations or observational data that suggests a near-complete disintegration might occur faster than on a multi-millennial time scale. Estimates of the Greenland ice sheet's maximum contribution to sea-level rise within this century amount to around 54 cm. The West Antarctic ice sheet in turn holds the equivalent of 5 meters, of which around 3 are potentially at risk of disintegration. Time scales for this amount of sea-level rise, however, are not available yet. Because the behaviour of ice sheets has not fully been understood to date and is not always accounted for in estimates of future sea-level rise, estimates vary from 18-59 cm to 215 cm of global sea-level rise by 2100.[128]

This growing rise in the world's seas affects coastlines everywhere. Higher seas have an erosion effect on coastlines, damaging shore life, property, infrastructure, and local ecosystems, all of which can be quantified. The lowest land areas can be completely submerged, in particular during high tides or brief surges in sea-levels caused by heavy

ALMOST 10% OF THE WORLD'S TOTAL POPULATION LIVE IN AREAS FROM ZERO TO JUST 10 METERS ABOVE SEA-LEVEL

storms.[129] Other important effects, such as salt contamination of soil and water supplies or heightened impacts from storms, due mainly to storm surge, are covered in the chapters on Weather Disasters and Economic Stress respectively. Damage to cultural assets, tourism, and transport systems are not readily quantifiable and have not been taken into account.

Almost 10% of the world's total population live in areas from zero to just 10 meters or 30 feet above sea-level, including many of the world's largest cities.[130] All these populations should be considered under great pressure due to climate change. However, the most vulnerable populations are those that cannot afford to build up land or sea walls to preserve against erosion, soil and water contamination, storm flooding, and total loss of dry land to the seas.

The 200-300 million people living in the rural areas of these zones in countries with High vulnerability or above should be considered potential climate migrants or displaced people. The economic losses that these rural and urban communities incur due to climate change are used as the indicator of impact in this report. We have based our estimates on the findings of a major international collaboration called DIVA (Dynamic Interactive Vulnerability Assessment), which calculates economic impacts caused by climate-driven sea-level rise all around the world.[131]

DESERTIFICATION

While over-grazing, over-cultivation, deforestation, and unsustainable use of water supplies are well documented as the main causes of desertification, climatic factors such as higher temperatures and stronger high winds, have a clear aggravating effect on the phenomenon.[132]

In many areas, including desertification-prone lands, temperatures can be as much as a year-long average of 5 degrees Celsius (9 degrees Fahrenheit) hotter than the norm.[133]

While the higher temperatures brought by climate change will increase rainfall in general (because higher temperatures intensify water evaporation), that effect will be isolated to specific areas. Most drylands and deserts will not benefit from the increase. In fact, shifting rainfall patterns are, in many cases, making already marginal arid zones even drier.[134]

A combination of continuous and extreme heat and lack of rainfall in already marginal arid lands gradually or abruptly kills off plants, trees, and other vegetation. That can push the local ecosystem into a vicious cycle as evaporation of remaining water or rainfall deposits increases due to a lack of shade. Soil salinity rises as water leaves the ground at pace, harming any new growth prospects. Unable to block out sunlight or heat during the day, or retain heat during the night, desert-like areas are plunged into repetitive hot-cold extremes that are hostile to most life-forms and that further discourage regeneration.[135]

Some areas of the world, such as the Horn of Africa, are experiencing recurring drought, which can force millions of people into crisis as ecosystems and rain-based water supplies completely collapse.[136]

But desertification occurs when degradation takes on a permanence that defies the natural or managed ability of a land to recover from drought when rains return. Arid land becomes desert, which is both difficult and costly to restore.[137]

Where degradation of arid or semi-arid regions is extreme, desert sand dunes can advance against little resistance, carried mainly by the winds. Desert expansion in some areas, such as the Gobi Desert, has reached an explosive 15 kms per year.[138] Dust storms, which can also assist the spread of infectious diseases, such as meningitis, are another hallmark of lands under threat from desertification.[139]

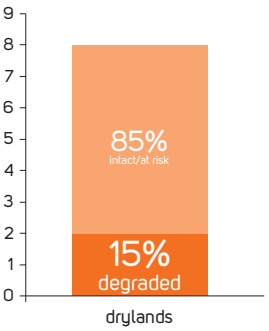
The harsh climate, ecosystem breakdown, lack of water and shade, and near irreversible degradation of land no longer fit for crops or grazing means most inhabitants have to uproot and leave.[140] More than 100 million people are living under pressure from desertification today, and that number is expected to significantly increase by 2030. These people should be considered potential climate migrants or displaced people. Not all desertified land creates migrants. It is possible for communities to persist in a desert environment, such as by benefitting from resources derived from peripheral land. But for most people, desertification implies abandonment of land and property.[141] Those who remain become even more vulnerable.

This report bases its findings on the PLACE II database (Population, Landscape, and Climate Estimates), which is managed by the Earth Institute of Columbia University, New York, and draws on US government observational information.

DESERT EXPANSION IN SOME AREAS, SUCH AS THE GOBI DESERT, HAS REACHED AN EXPLOSIVE 15 KMS PER YEAR

GLOBAL DESERTIFICATION

Percentage of degraded drylands (million sq km)



Source: Millenium Ecosystem Assessment; CIA Factbook

LINKS FROM CLIMATE CHANGE TO IMPACT INDICATORS

CLIMATE CHANGE EFFECTS	PHYSICAL CHANGES	VULNERABILITIES	IMPACT INDICATORS
• Rising sea-levels	• Shore retreat • Salinization • Back-water flooding	• Loss of wetlands • Loss of dry land • Protection cost • Migration cost	Impact of malnutrition • Described as deaths related to malnutrition and lower respiratory infection due to climate change
• Desertification	• Rising surface temperatures • Droughts • Water pressure	• Access to water for human and industrial use • Food – agricultural yields, species • Extreme heat • Wildfires • Conflicts (pastoral – Horn of Africa, northern Uganda and northern Kenya)	Loss of human habitat due to desertification • Described as climate change impact on the share of population living in climate zones at risk of desertification

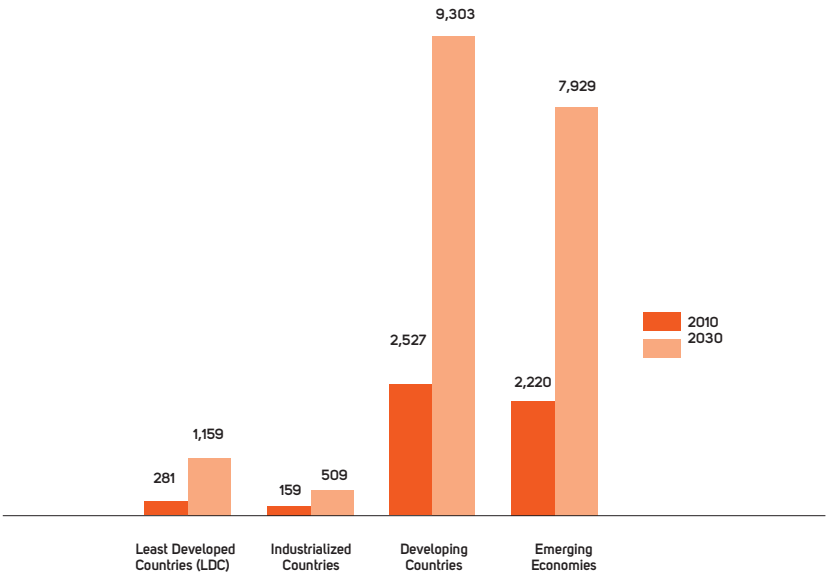
WHO SUFFERS?

Overall, the regions worst affected by habitat loss are Western Africa, Southern Africa, and the Pacific, followed by South Asia. The whole continent of Africa is among the most vulnerable.

THE SPREAD OF IMPACT: DESERTIFICATION

The distribution of climate-related desertification population risk by socio-economic group in 2010 and 2030

Additional persons at risk of desertification (1000s) average per year



The Pacific, the Caribbean, and Eastern and Western Africa are worst affected by sea-level rise.

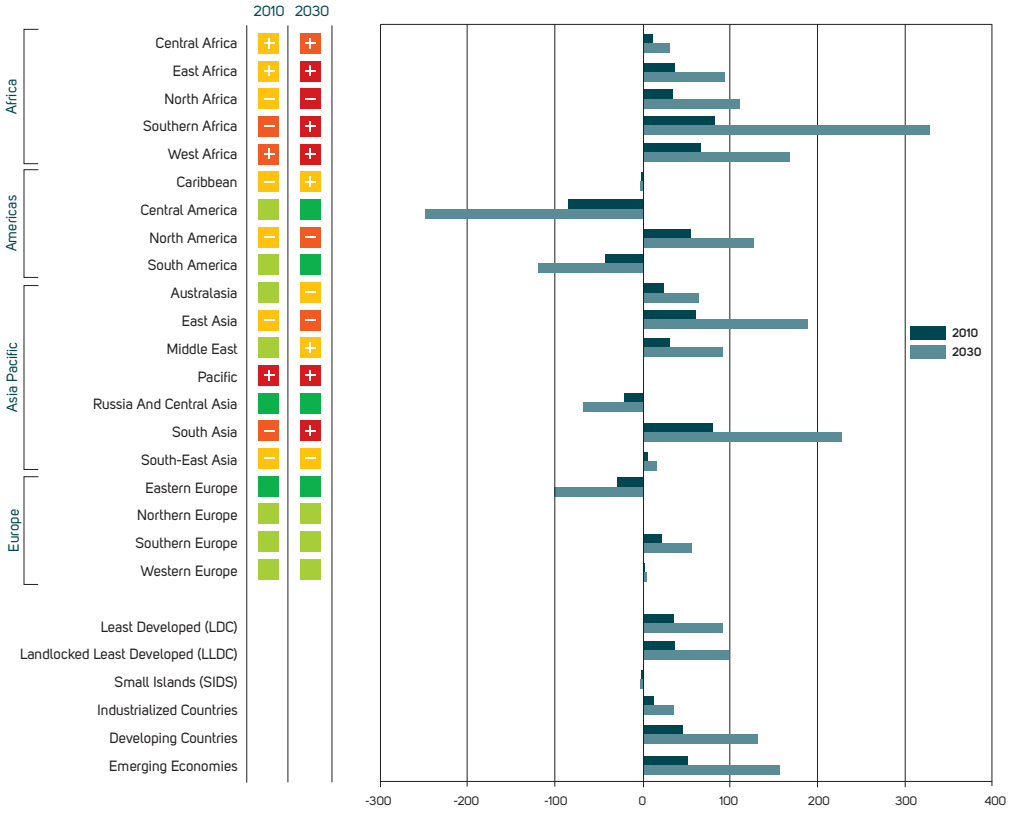
South Asia, Southern Africa, North Africa, North America, and East Asia are worst affected by desertification.

The countries projected to face the worst impacts of desertification are Botswana, Namibia, and Senegal. Namibia is the only country that is among the worst-affected by both desertification and sea-level rise.

The countries projected to face the most overwhelming impacts of sea-level rise are all small island developing states and countries in Africa. Guinea-Bissau is the country most vulnerable to sea-level rise. The river delta nation bordering on the Western Sahara Desert is projected to suffer extreme stresses. The losses that these countries are projected to incur correspond to a large share of their GDP each year. Large archipelagic countries, such as the Philippines, have not registered vulnerability as high as would be expected. This is because, statistically speaking, we calculate a lower vulnerability for countries with a lower ratio of coastline to overall land area than, for example, nations with proportionally more land area close to the sea, or higher levels of population and infrastructure clustered in low-lying coastal areas, such as the Maldives or Guinea-Bissau.

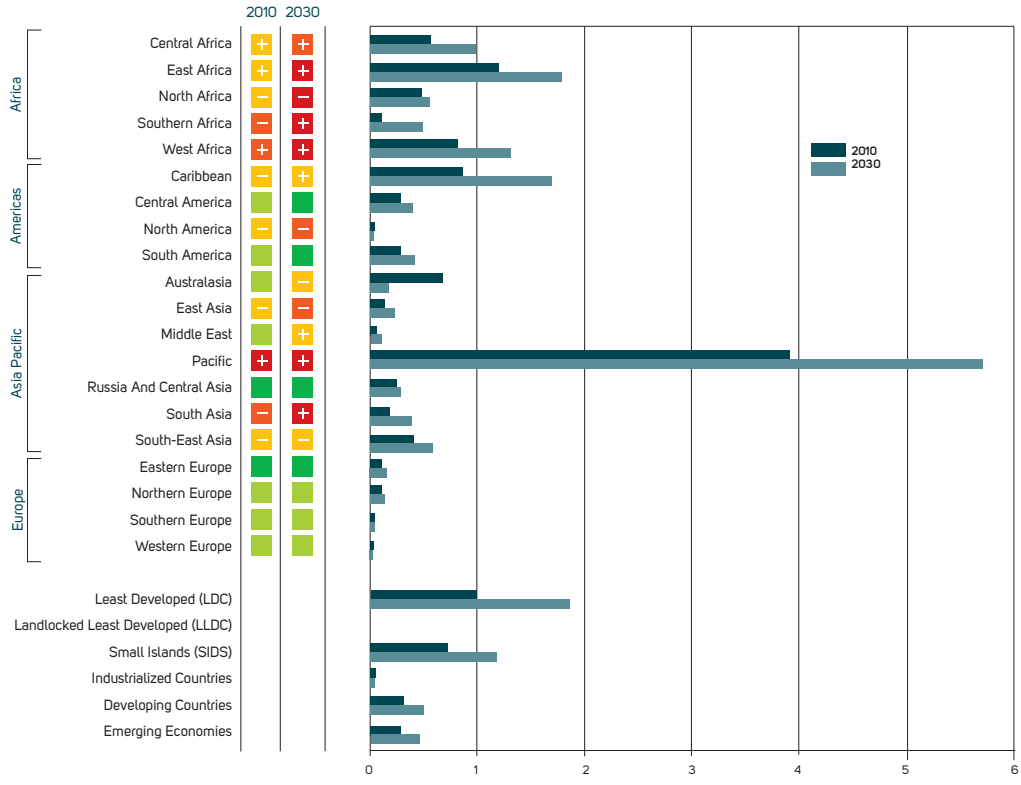
IMPACTS AROUND THE WORLD: DESERTIFICATION

The regional and socio-economic distribution of climate-related additional persons at rist of desertification relative to population in 2010 and 2030
Additional persons at risk per 100,000



IMPACTS AROUND THE WORLD: SEA-LEVEL RISE

The regional and socio-economic distribution of sea-level rise costs relative to gdp in 2010 and 2030
Additional losses (percent of GDP)



By evaluating impacts in these relative terms, we are best able to make comparisons across countries and points in time. And because these impacts are assessed in relation to local populations and levels of income, they are not skewed by different sizes of populations and levels of economic activity. Relative indications of economic losses are also more comparable between poor and wealthy countries because they take into account a country's underlying per capita income level. However, this "equity weighted" expression of economic impacts does not go as far as some indices in expressing the high vulnerabilities of the poorest communities around the world.

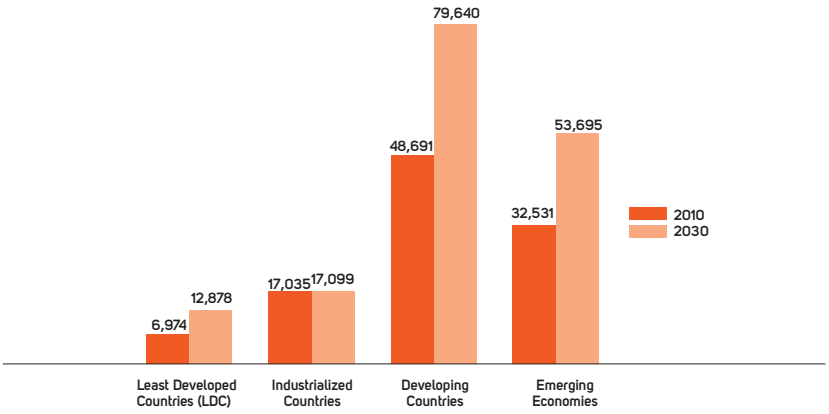
It is also important to note that estimates of absolute impact in 2010 and 2030 may increase both due to increases in climate change impacts and due to population and economic growth.

In absolute terms, 80% of the excess persons at risk due to desertification in 2030 are projected to live in China and India. The 10 countries with the largest populations at risk to desertification due to climate change bear almost the entire global burden. Among developed countries, the United States and Spain are the worst-affected in absolute terms.

China and India are also the countries projected to face the largest absolute economic losses due to sea-level rise. Other countries in Asia and Latin America, as well as the United States and Russia are also projected to suffer significant losses. Overall, the 10 worst-affected countries in absolute terms bear about half of the global economic losses caused by sea-level rise.

THE SPREAD OF IMPACT: SEA-LEVEL RISE

The distribution of climate-related sea-level rise losses by socio-economic group in 2010 and 2030
Additional economic losses (million USD PPP) average per year



A number of countries are protected from the habitat loss impacts described in this chapter because they are neither on the sea nor have dryland areas. In Asia, examples of these countries are Laos and Nepal; in Africa, Burundi and Rwanda; in Europe, Austria, Belarus, Czech Republic, Slovakia, and Switzerland.

The least-affected countries are in regions where a reversal of desertification trends is projected. These projections suggest that there are countries in Central Asia and Latin America that could experience benefits in terms of desertification.

THE IMPACT TOMORROW: 2030

Roughly 20 countries are severely or acutely impacted by habitat loss today, and that number is set to rise to 25 by 2030 (note that a number of small island states are not included among the 184 countries covered in this report due to a lack of data in a number of areas). Some of the lowest-lying areas are found in wealthy countries such as the Netherlands or the United States. North America, Australia, and parts of Mediterranean Europe are also home to some of the world's most arid regions. However, the key measure of vulnerability is whether a country must suffer through the changes as opposed to fending them off through significant investments. This is why wealthier nations are rated as less vulnerable than poor countries even where they may face similar impacts.

The regions projected to face the worst habitat losses between 2010 and 2030 are North Africa and the Middle East. In that same time period, South Asia and Southern Africa both move from High to Acute factors.

Several countries will experience a significant acceleration of exposures to habitat loss impacts between today and 2030. The deterioration in these countries, mainly in Asia and Africa, is primarily driven by desertification.

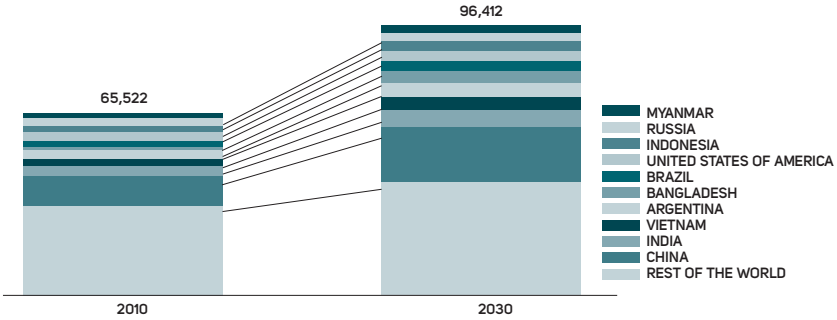
WORST HIT AND LEAST HIT (2030)

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

WORST	LEAST
GUINEA-BISSAU	AZERBAIJAN
NAMIBIA	TAJIKISTAN
KIRIBATI	VENEZUELA
MARSHALL ISLANDS	TURKMENISTAN
MALDIVES	UZBEKISTAN
BOTSWANA	MEXICO
SOLOMON ISLANDS	KYRGYZSTAN
SENEGAL	PERU
TUVALU	COLOMBIA
SOMALIA	UKRAINE

HOTSPOTS: SEA-LEVEL RISE

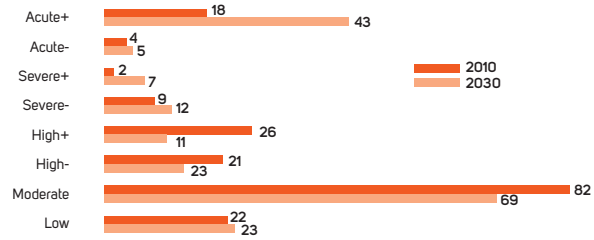
Countries with the largest total climate-related sea-level rise losses
Additional losses (million USD PPP) average per year



VULNERABILITY SHIFT

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

Number of Countries by Vulnerability Factor

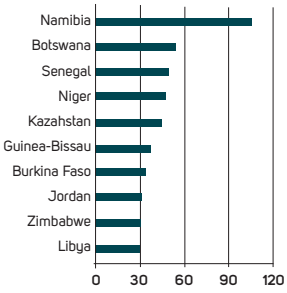


A group of already-vulnerable Western and Southern African countries are projected to be among the worst-affected by incremental habitat loss due to climate change between 2010 and 2030. Countries with large populations living in drylands outside Africa will also face accelerating stresses, including Kazakhstan, Jordan, and Libya.

HIGH SURGE VULNERABILITY

Countries with the fastest growing climate-related habitat loss between 2010 and 2030

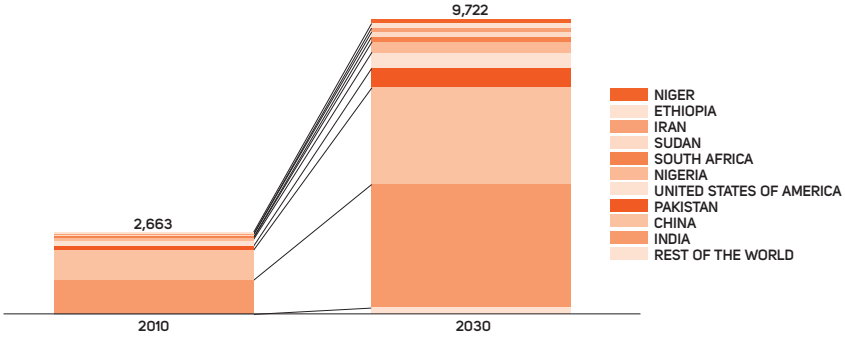
Percentage increase in climate-related habitat loss



HOTSPOTS: DESERTIFICATION

Countries with the largest total climate-related desertification population risk

Total additional persons at risk (1000s)



SPOTLIGHT: MULTIPLE HABITAT STRESS

Most countries are either affected by sea-level rise, or by desertification, or by neither. Desertification is usually a continental problem, since the centres of landmasses are less regulated by the constant temperatures of the sea, and can experience greater hot and cold extremes. In fact, many countries badly affected by desertification are landlocked states like Botswana, Niger, or Kazakhstan. Sea-level rise, of course, only stresses coastal areas. Nevertheless, a handful of countries, mainly in Africa, are badly affected by both sea-level rise and desertification -- in particular, Eritrea, Mauritania, Mozambique, Senegal, and Somalia. Outside of Africa, countries like Myanmar and Australia are also suffering from both stresses.

Countries affected by sea-level rise and desertification are fighting a battle on two fronts. Each of these stresses has quite different effects and requires very different responses, although both can involve the temporary or permanent disappearance of human habitats, and either could lead to displacement and migration of people to higher, more protected or less stressed lands. Sea-level rise particularly affects the economy through lost investment opportunities. Investments are instead spent on maintaining costly coastal infrastructure and protecting lands and communities at risk from inundation. Desertification reduces the land area available for agricultural purposes or human habitation. Most of the African countries suffering both types of impacts have low-lying coastlines and territories that back onto the Sahara Desert. Australia is a continent unto itself containing deserts and one of the largest coastlines in the world, which make it highly vulnerable to both those effects.

The compounded growth of this double pressure could sap significant economic and environmental potential from the affected countries, and so demands an intensive coordinated response. If no action is taken, people and communities will be increasingly endangered or forced to relocate. Either way, in the absence of external support, these pressures will very likely hold back socio-economic progress in some of the world's poorest countries. In the case of Somalia, this dual threat adds further complex stresses to its extreme fragility.

THE ASSESSMENT

The Monitor assesses loss of human habitat through climate-change driven desertification, or the degradation of dryland areas, via satellite-based mapping of land degradation evident (from the PLACE II database)[142] and a climate model (called IMAGE) that ascertains a likely aggravating role of climate change.[143] The indicator used is the population at risk from desertification. The indicator is fairly robust, since countries with a high factor of vulnerability will all have relatively large land-degradation problems verified by satellite imagery, and we can assess where this degradation appears to be worsening due to the effects of climate change. The Monitor assesses populations at risk relative to total population and assesses economic costs of sea-level rise proportional to total GDP to take into account the relative importance of these impacts for a given country.

The Monitor assesses loss of human habitat through sea-level rise via a complex global satellite-based model, DIVA, that calculates the cost burden on communities in coastal areas around the world.[144] Since it is based on satellite imagery, the indicator is fairly robust in conveying physical vulnerabilities. The model then weighs in the scale of exposure and costs of ongoing stress to communities in different coastal areas as lost GDP potential.

Despite its robustness, some results are surprising. Countries of the Arabian Peninsula, for example, such as Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates, and Yemen, all share Moderate factors of vulnerability. None are deemed to be suffering impacts of desertification, since their environment is either already classed as desert or as urban or otherwise, but not as dryland-facing-degradation. Neither do any of these countries register any significant sea-level rise vulnerabilities.

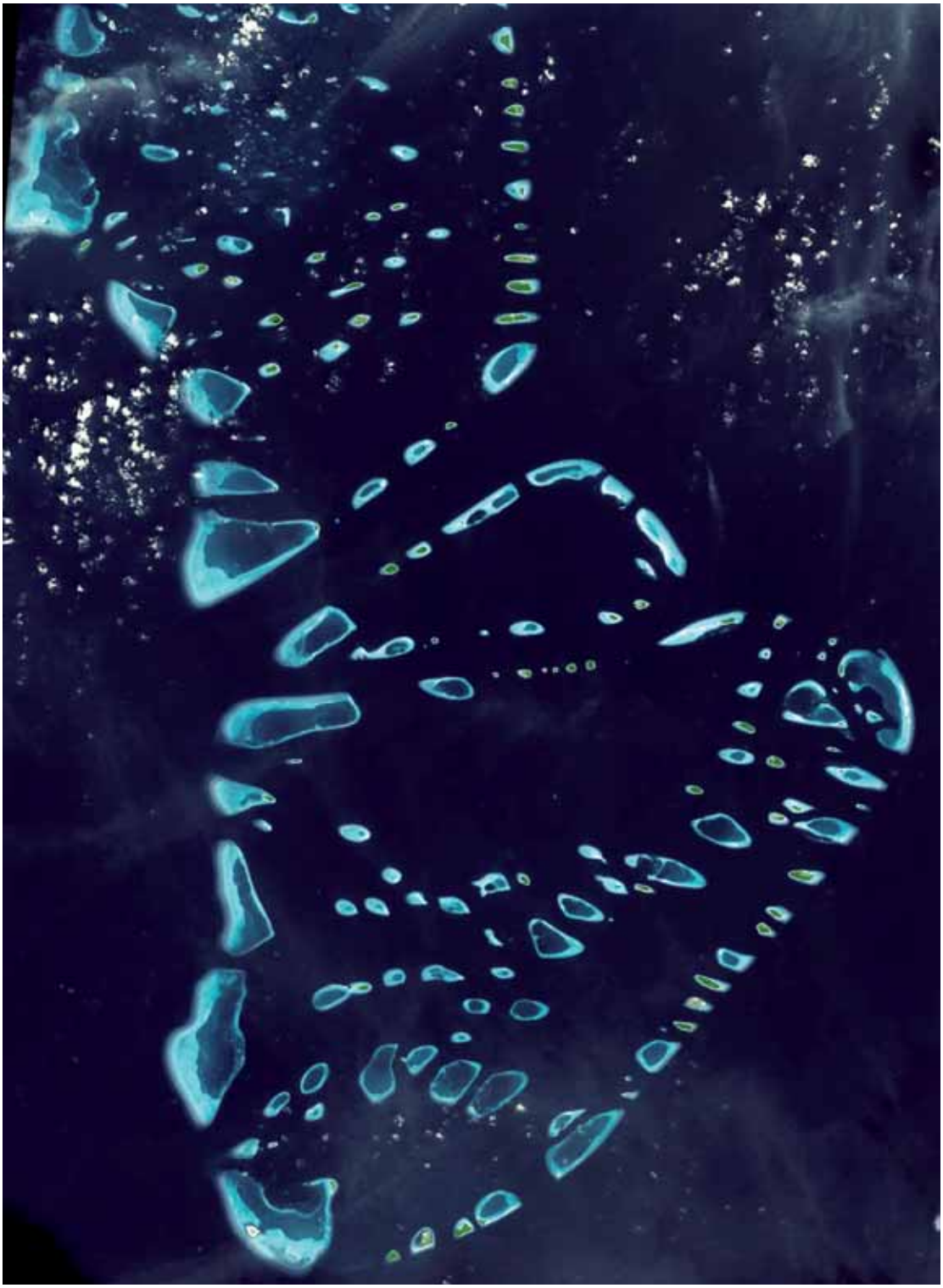
Bangladesh (Moderate/Moderate) is well known for its populous, low-lying coastal delta, but it is far less vulnerable than many other countries for reasons of scale. Bangladesh's coastline is just 580 kilometres or 360 miles long. Less than 15% of the country's population of more than 160 million people live in coastal areas below 5 metres (16 ft) altitude.[145] This compares with 100% for more vulnerable countries like Kiribati, Maldives, and Tuvalu. Bangladesh is also almost 500 times larger than Maldives in terms of total land area, with most of its territory well inland from the sea.[146] Similar rules apply to the Philippines (Moderate/Moderate). Despite having the fifth largest coastline on the planet, the Philippines has much less of its population in coastal areas below 5m/16ft than Bangladesh. Meanwhile, Canada (Moderate/Moderate) has similar vulnerability to Bangladesh and Philippines by virtue of possessing by far the largest coastline in the world (some 30 times that of the Philippines or more than 15,000 times that of Bangladesh), despite the fact that it has minimal populations living in low-elevation coastal zones.[147]

Scale also plays a role in comparative vulnerability to desertification. So when a compact country like Bhutan (High+/Acute+), which is roughly the size of Switzerland, suffers from growing degradation of its savannah and steppe-type lands, proportional pressure on its inhabitants is much higher than in huge countries like Algeria (Moderate/Moderate), where populations are far less concentrated around at-risk areas.

In Africa, the Central African Republic (Moderate/Moderate) has already suffered limited desertification but does not suffer from water stress extremes and should continue to receive more rainfall as a result of climate change (as will much of Central Africa).[148] Neighbouring Cameroon (Moderate/High-), however, is worse off, particularly where its northern border once met the now almost completely vanished Lake Chad. And heavily-populated Sudan (High+/Acute+) is set to suffer increasing degradation of its dryland regions along the margins of the Sahara Desert as temperatures continue to rise.

Four highly-developed countries register high factors of vulnerability to habitat loss: Australia, due mainly to desertification; Iceland, due to sea-level rise alone; Spain, due exclusively to desertification; and the United States, also due in particular to desertification. Iceland (High-/High+) has quite a small population (around 300,000) but a long coastline, similar in size to Argentina's. Almost all of its inhabitants live within 100 kilometres (60 miles) of the sea, which amplifies socio-economic vulnerabilities to growing coastal stress. In Spain (High-/Acute+), existing stresses on water supplies run headlong into less rain and more heat brought by climate change. While Australia (Moderate/High+) and the United States (High-/Acute-) are home to some of the largest dryland areas on the planet, both of which are becoming hotter and dryer as the planet warms up. Parts of the US, in particular, key areas of Southern Florida, are of very low elevation, so local vulnerability to rising seas is high. Nationwide, however, the US does not suffer sea-level rise impacts compared to those experienced by island nations or countries like Guinea-Bissau whose geographies are dominated by large river deltas.

Netherlands (Moderate/Moderate), one of the lowest lying countries in the world -- Half of the country lies below 1 meter (3ft) above sea-levels including one eighth of the country lying below sea-level -- has a surprisingly low levels of vulnerability to habitat loss /sea-level rise. Netherlands, however, is also one of the best prepared countries in the world in dealing with sea-level rise through robust protective measures such as dams, polders, dykes and dunes. The low-lying geography of the Netherlands has long dominated the country's development, with key infrastructure already long in place to allow for the productive use of below-sea-level coastal zones. The Netherlands does therefore not have to yet react to the same degree to protect its resources from coastal erosion or the dangers of sea-level rise to any significant extent when compared with other seriously affected countries. Adaptation to sea-level rise for the Netherlands may only imply in most cases an incremental reinforcement of existing infrastructure. Nevertheless, the total costs of this adaptation can be very large in absolute terms, but are small in size when compared with the overall scale of the Dutch economy -- one of the 20 largest economies in the world.



The Maldives archipelago, seriously affected by sea-level rise. Source: NASA/GSFC/METI/ERSDAC7JAROS, and U.S./Japan ASTER Team

ECONOMIC STRESS

Many economic sectors are sensitive to climate, just as many diseases are. While in the short to medium term some regions will reap benefits from warmer weather, overall, the additional stress of climate change will harm economic output and growth. It will also contribute to worsening global inequalities, since the economic impacts of climate change are, in general, most disadvantageous to the poor and most advantageous to the wealthy. The primary sectors of the economy are most sensitive to climate change, in particular agriculture, crops, livestock, and fisheries. Valuable environmental assets such as coral reefs, alpine rainforests, and species are also impacted negatively by global warming.

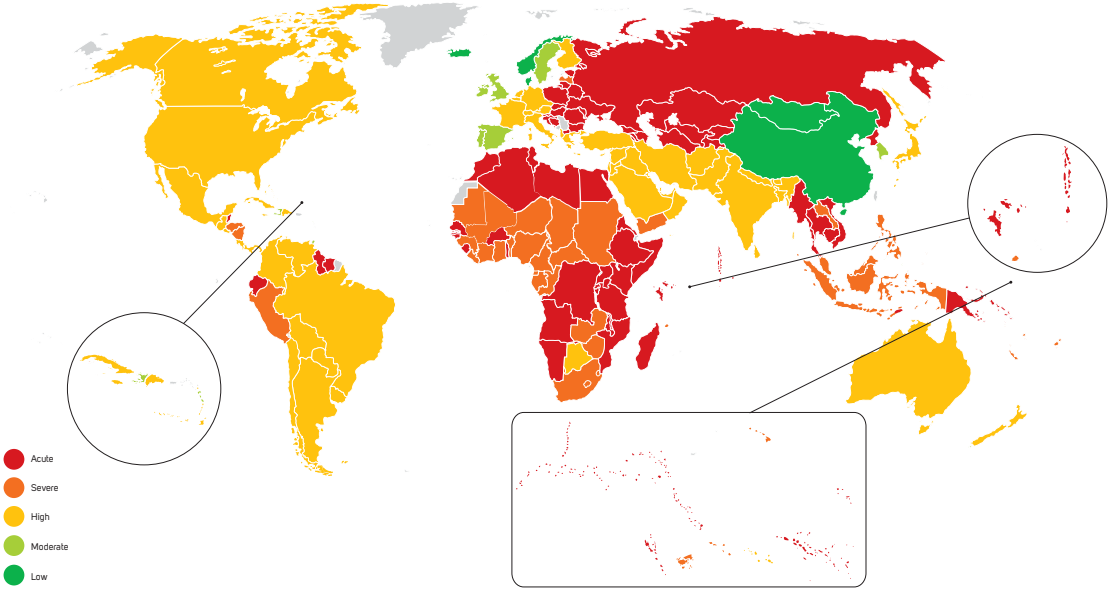
2010
CLIMATE EFFECT TODAY
65 BILLION DOLLAR IMPACT PER YEAR

2030
CLIMATE EFFECT TOMORROW
160 BILLION DOLLAR IMPACT PER YEAR

FINDINGS

GLOBAL VULNERABILITY TO CLIMATE ECONOMIC STRESS

Countries by overal climate vulnerability for economic stress



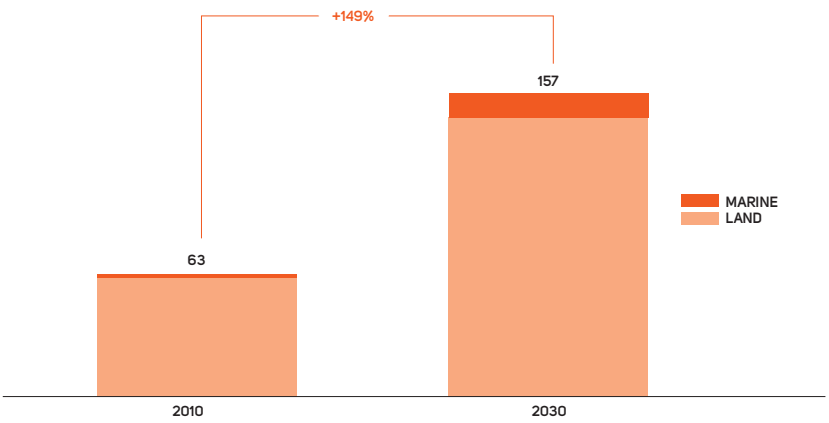
This section focuses on the incremental economic stresses climate change is placing on productive sectors in the economy. These economic losses occur in addition to the climate change impacts described in other chapters of this report, such as the immediate damage costs of extreme weather and economic losses due to sea-level rise.

These economic stresses are set to significantly widen the gap between wealthy and poor. In most cases, the economic impacts of climate change are actually making the rich richer, for example in some sectors of Northern Europe. The worst losses are being felt in countries that are already poor, especially in Africa, Central Asia, and Southeast Asia.

Globally, estimated economic stresses due to climate change point to losses of USD 63 billion each year today. This impact will rise by more than 100% to USD 157 billion each year by 2030.

GLOBAL CLIMATE ECONOMIC STRESS IMPACT BURDEN

The change in the scale of global climate-related economic losses from 2010 to 2030
Additional Economic Losses (billion USD PPP)



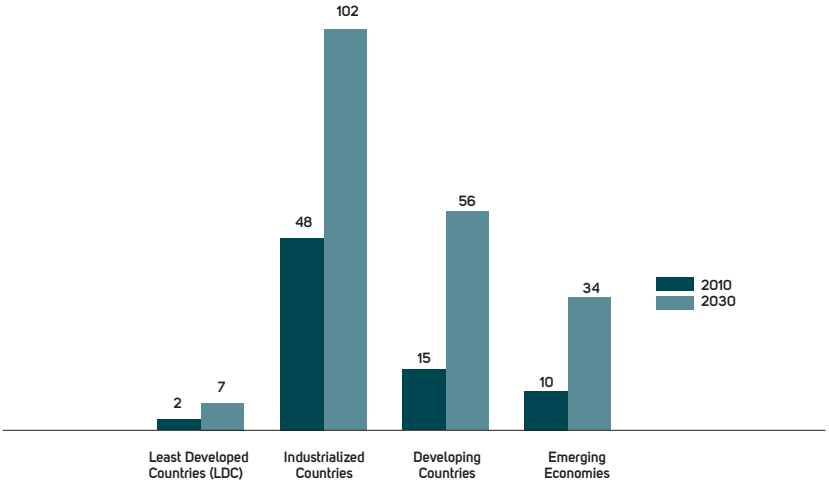
The economic stress due to climate change captured in this report is primarily based on primary sectors such as fisheries, forestry, and other agricultural losses or gains. It is to a great extent driven by water resource impacts and climate effects on biodiversity.

The estimates of economic stresses expressed here provide only a partial picture. Other important economic sectors are likely to be affected by climate change, including energy, tourism, and other service sectors, but good estimates are not yet available for many countries. The national and regional estimates provided here also often fail to capture the exposure of communities within countries that are particularly impacted by climate change. There is an urgent need to study these impacts in greater detail, particularly in developing regions that currently have the poorest access to such information. Still, the available projections provide a good barometer for economic impacts that will also be felt across other sectors of the economy.
More than half the total losses due to economic stresses brought on by climate change will be in industrialized countries. Large developing countries will also bear a significant burden. Least developed countries experience much harder impacts relative to the size of their economies, but since the GDP of lower-income countries is by definition much smaller, their impacts also contribute less to overall global losses. Projected economic losses are set to grow significantly between 2010 and 2030, both due to the increasing impacts of climate change and due to the projected underlying economic growth. Roughly half of the projected increase of 150% is explained by climate change and the rest by the underlying economic growth.

MORE THAN HALF THE TOTAL LOSSES DUE TO ECONOMIC STRESSES BROUGHT ON BY CLIMATE CHANGE WILL BE IN INDUSTRIALIZED COUNTRIES. LARGE DEVELOPING COUNTRIES WILL ALSO BEAR A SIGNIFICANT BURDEN

THE SPREAD OF IMPACT: ECONOMIC LOSSES

The distribution of climate-related economic losses by socio-economic group in 2010 and 2030
Additional Economic Losses (billion USD PPP) average per year



IMPACT DYNAMICS

The climate is changing. Temperatures are higher, rainfall is decreasing in some places, increasing in others, and the atmosphere carries more energy and humidity, bringing more wind and more uncertainty.[149] These changes will stress communities around the world in ways that impact economic values. Some communities will benefit overall, some will suffer overall, but all communities are likely to experience stresses that reduce economic growth as the environmental change brought about by global warming intensifies.

PEAK IMPACT ECONOMIC STRESS ▲

1999-2001	Iran	Drought	37 million affected- $3.3 billion in damages[150]
2000	Australia	Locust Infestation	Largest outbreak recorded - $120 million in damages[151]
2002	India	Drought	300 million affected - $910 million in damages[152]
2002	United States	Drought	$3.3 billion in damages[153]
2004-2005	Brazil	Drought	$1.65 billion in damages[154]
2006	China	Drought	18 million affected- economic damage of $2.9 billion[155]

Our planet's climate has changed dramatically over its billions of years of existence. In the last 650,000 years, there have been seven distinct ice ages – two since the emergence of people (homo sapiens) some 200,000 years ago. The last ice age ended around 10,000 BCE. Modern civilization emerged during the interglacial (or warmer) period since then, and for much of this time a relatively stable climate has been the norm.[156] The rapid

warming in global temperatures by almost 1 degree Celsius or 1.8 degrees Fahrenheit since the 1900s represents a pace of change on a level that is unusual in nature and completely unprecedented for human civilization. And this rate of change is rapidly accelerating as we continue to pollute the earth's atmosphere.[157]

Over long time periods, the earth would adapt to the changes thrown at the environment. Coral reefs may die out in the warmest waters but grow in colder -- warming -- waters, which might present a more favourable habitat. Water may drain from one part of the world and accumulate elsewhere.[158] However, the costs of such fundamental transformations are likely to be very high to the generations that live through them.[159] In today's world, entire nations or economies cannot reasonably be expected to uproot, nor does the life of a human being last long enough in most cases to see long-term regenerative transformations realized in nature. This report's focus on today and the near future means that many of the potential long-term gains, such as new farmland in remote uninhabited pre-Arctic regions, are unlikely to be reaped to their full potential.[160] Likewise, technological solutions yet to be developed should not be counted on to face off or counteract negative impacts in the near future.

Some economic sectors are more dependent on environmental conditions than others. Agricultural productivity is highly dependent on temperature and precipitation.[161] Water supply is dependent on how precipitation patterns and evaporation rates change.[162] The catch potential in fisheries is dependent on water temperatures and the acidity level of oceans, which is rising in large part due to climate change.[163] Researchers have built complex economic models to estimate projections for economic stresses due to climate change in these sectors.[164]

Economic models can also estimate economic impacts on non-market sectors.[165] The stresses described in this chapter include projections for the economic impacts on natural ecosystems, for example. Climate change is projected to have irreversible effects such as the loss of species and the deterioration of complex natural ecosystems.[166]

Climate change is also projected to result in added costs to other sectors. For example, more extreme temperatures will have a significant impact on the costs of energy for heating and cooling.[167] But these costs are usually regarded as adaptation costs rather than direct economic stresses, so they are excluded from the estimates in this chapter.

Agriculture is sensitive to climate change in a variety of ways, not all negative. In mid- to high-latitude regions, particularly in the northern hemisphere, moderate increases in temperature and rainfall changes are expected to lead to a small gain in crop yields and livestock production.[168] Increasing concentrations of CO_2 in the atmosphere may also benefit crop yields, making crops grow faster and more efficiently, although the extent to which this is the case is still debated.[169] Common weeds, for example, are found to benefit most from the CO_2 effect, which is one key factor counteracting its potential benefits.[170]

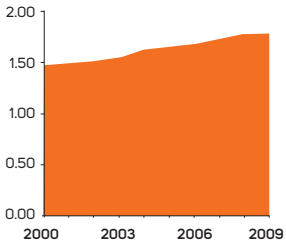
Low-latitude regions are expected to experience negative yield impacts for major cereals such as wheat and rice. The loss of water resources in areas that already experience high levels of water stress and low precipitation can have significant negative effects on agriculture. We expect that these effects will be compounded by the increased frequency of extreme weather events such as drought, flooding, and fires. These impacts are expected to affect vulnerable groups in the poorest countries the most. Smallholder and subsistence farmers are particularly vulnerable. The national statistics presented in this report often do not sufficiently convey the vulnerabilities of these communities.[171]

However, we expect that forestry as a sector will not suffer overall heavy economic losses in the near term. The outputs of forest products are also projected to enjoy some benefits from increased CO_2 concentrations. But forestry will suffer some of the same challenges as agriculture, particularly where water is scarce and where the frequency of extreme weather events increases.[172] Over time, some trees will no longer be suited to a warmer climate, while other trees will become more relevant.

ENTIRE NATIONS OR ECONOMIES CANNOT REASONABLY BE EXPECTED TO UPROOT, NOR DOES THE LIFE OF A HUMAN BEING LAST LONG ENOUGH IN MOST CASES TO SEE LONG-TERM REGENERATIVE TRANSFORMATIONS REALIZED IN NATURE

GLOBAL AGRICULTURAL PRODUCTION

Billions of Dollars (Gross)

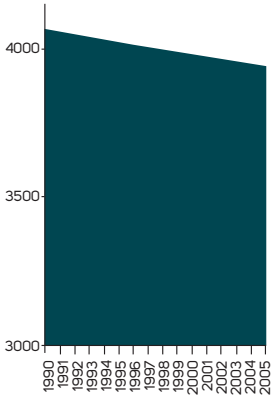


Source: FAO

Agricultural production is expanding around the world, due mainly to increases in living standards in developing countries, particularly in Asia, but also because of continued global population growth. In the short term, the impacts of climate change on agriculture, in particular, food production will be worst on a local level. But in time the global impact on agriculture will worsen around the world.

FORESTS

Hectares (millions)

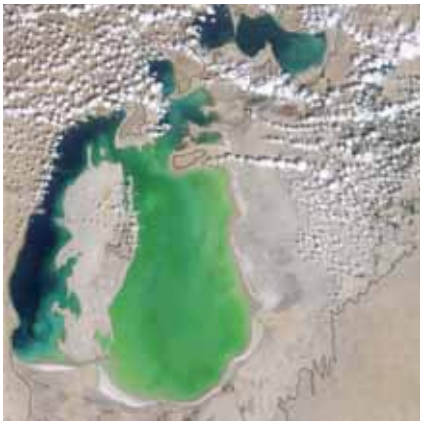


Source: FAO Global Forest Resources Assessment 2005 (FRA 2005)

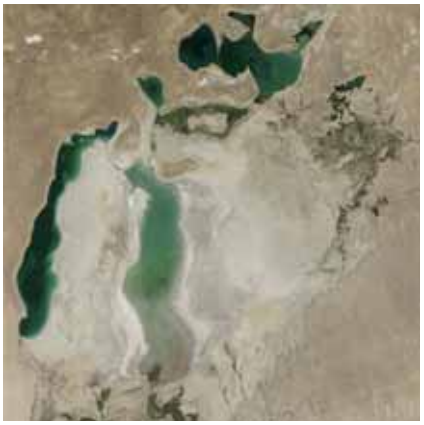
A drop in the land area of forests is mainly due to deforestation to make way for additional agricultural production for food, bio-fuels and other non-forestry purposes. The slash and burn tactics used in many cases to remove forests is also a major contributor to global emissions of greenhouse gases.

Water supply is expected to decrease due to climate change around the world but particularly in regions already affected by water stress such as Central Asia, North Africa, and Sub-Saharan Africa.[173] Widespread glacial melt is causing local surges in water in some cases, but the overall trend is depletion, which already stresses local water supplies in mountainous or mountain-fed countries affected by the phenomenon.[174]

Aral Sea year 1989



Aral Sea year 2000



Aral Sea year 2010

Source: NASA

The Aral Sea is one of the most striking examples of environmental degradation on the planet today. One of the four largest freshwater lakes in the world some 50 years ago, it has now almost completely vanished. Unsustainable exploitation of the Aral Sea's water stocks for commercial purposes is the main cause of its dramatic disappearance. However, some climate models do point to higher temperatures and less rainfall on the east coast of the Caspian Sea in the region of the Aral Sea. Any role of climate change is difficult to disaggregate, but clearly rapidly rising temperatures and lowered rainfall will only exacerbate existing water resource mismanagement. Time will tell if more stringent measures will allow the lake to regenerate with the same speed as it disappeared.

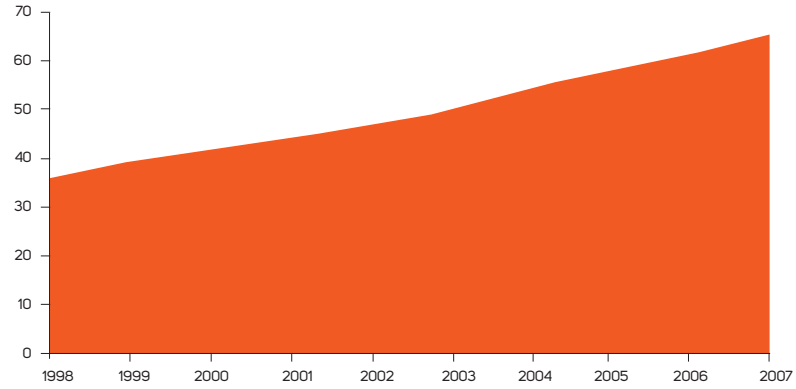
Economic stresses affecting natural ecosystems are expected to have significant costs already today and in the near term.[175] For example, higher temperatures are especially affecting alpine species whose habitats are rapidly disappearing. Boreal forests will completely disappear in some places, to be replaced by more temperate species.[176] Mountainous countries of Asia and South America are particularly impacted, since temperature increases are felt more strongly in alpine climates.[177] Sea-level rise is also damaging coastal wetlands inundated by salt water. Wetlands of this kind are among the most diverse habitats for species of all kinds – birds, insects, fish, and mammals.[178] Their decline is a tragedy for the planet similar in scale to the almost inevitable disappearance of the world's coral reefs.[179] The loss of species is a particularly dramatic effect of this environmental degradation. Indigenous populations that rely on the strength of the biodiversity of their local environment are particularly vulnerable to ecosystem damage of this kind.[180]

The latest studies of the impact of climate change on fisheries point to a dramatic redistribution of the global maximum catch potential between different parts of the world. The tropics are projected to suffer a drop of up to 40% in catch potential by 2055, while high-latitude regions are projected to see a 50% increase in the same period.[181] Overall, though, the expected impact of climate change on fisheries is negative. This dynamic is taking place against a background in which many of the world's fish stocks are facing depletion or are already in decline due to unsustainable fishing practices that continue to increase production and catch but are eating away at the world's fish stocks.[182] Warmer waters favour disease in fish and growth of toxic algae that kill fish and the aquatic life they feed from.[183] Higher temperatures are also fatal to coral, whose bleaching effect is greatly accelerating around the world. But warming northern seas and the disappearance of ice covering the Arctic seas will bring about a large increase in fish stocks in these areas, although not enough to compensate for losses elsewhere. This is particularly bad news for the one sixth of the world's population, mainly living in developing countries close to or within the tropics, that relies on fish as a principal food source.[184] And the impacts on fisheries are not limited to the world's oceans.[185] The second largest body of fresh water on the planet, Lake Tanganyika, an East Africa great lake, has become warmer, increasingly stratified, and less productive over the past 90 years. The problem of

freshwater fish stock depletion over and above unsustainable fishing is comparable to that of stock depletion in the warming oceans. However, there is insufficient scientific basis and data available for the Monitor to take into account the impact of climate change on freshwater fish stocks. This is an area that merits urgent research given that many river delta countries, and communities relying on large lakes like Lake Victoria, derive significant proportions of their agricultural economy and also their diet from freshwater fish.[186]

FISHERIES PRODUCTION

Tons (millions)



Global fishery production has been expanding rapidly but at highly unsustainable rates that are depleting fish stocks around the world.

The impacts of climate change on these primary sectors are likely to result in a significant shift in production from low-latitude to medium- and high-latitude regions.[187] These impacts add increased pressures on the food security of the poorest communities, which will face colossal health impacts of malnutrition, especially in children, as is estimated in the Health Impact chapter in this report.

It is also possible to calculate the share of disease burden attributed to climate change in economic terms as lost productive output due to sickness or death. This report has not included such calculations in its assessment of economic stresses. However, the Report of the Commission on the Macroeconomics of Health calculated, for instance, that in 1999 HIV/AIDS was costing Sub-Saharan Africa between 5.8 and 17.4 percent of GNP potential every year.[188] At the time of estimation, HIV/AIDS was estimated to be responsible for 36 million disability-adjusted life years (DALYs) or years of active life foregone due to injuries/illnesses, including premature death. In 2000, the WHO estimated that climate change was responsible for 5.5 million DALYs. The amount for 2010 would be more than double that given that this report estimates climate-related mortalities are now over 350,000 per year, compared with the 150,000 estimated by the WHO for one decade ago.[189] That figure could potentially more than double once more by 2030, with an economic impairment that is difficult to calculate, but potentially very large.

The prices of basic foodstuffs net of any influence from climate change are already expected to rise by 2050 in real terms by between 39 and 72 percent, depending on the foodstuff, as a result of expected demand shifts, population growth, and competition with biofuels for land.[190] In a situation of such extreme scarcity, the expected decline in agriculture due to climate change could force a tripling of the price of wheat based on estimations by the International Food Policy Research Institute.[191] The 2007-2008 global food crisis led to widespread civil unrest and outbreaks of hunger when a spike in oil prices, drought, and other factors dramatically inflated food prices.[192] If that is any indication of how such outcomes might affect the world's poorest communities, the impact of further surges in food prices could have devastating consequences.

THE EXPECTED DECLINE IN AGRICULTURE DUE TO CLIMATE CHANGE COULD FORCE A TRIPLING OF THE PRICE OF WHEAT

LINKS FROM CLIMATE CHANGE TO IMPACT INDICATORS

CLIMATE CHANGE EFFECTS	PHYSICAL CHANGES	VULNERABILITIES	IMPACT INDICATORS
• Rising surface temperatures • Changes in local rainfall • Increased CO_2 in atmosphere	• Land degradation and desertification • Water pressure • Loss of soil fertility • Landslides and erosion	• Reduced crop yields • Loss of livestock productivity • Loss of income for farmers	Agriculture sector loss/gain • Described as the economic value of impacts on the agriculture sector due to climate
• Rising surface temperatures • Changes in local rainfall and river run-off patterns	• Loss of forest and wetland ecosystems • Loss of soil fertility • Landslides and erosion • Changes in coastal morphology	• Loss of forest and wetland ecosystems • Energy insecurity and deforestation (biomass)	Forestry sector loss/gain • Described as the economic value of impacts on the forestry sector due to climate change
• Rising surface temperatures • Changes in local rainfall and river run-off patterns	• Sediment pollution • Desertification • Salinization of fresh water resources • Melting glaciers • Precipitation and evaporation rates, including flooding and drought	• Decreased accessible water stocks	Water resources loss/gain • Described as the economic value of impacts on water resources
• Loss of biodiversity and ecosystem services	• Gradual environmental degradation	• Accelerated species extinction rates • Species migration • Loss of ecosystem services	Species/ biodiversity loss/gain • Described as the economic value that people are assumed to place on the impact of climate change on ecosystems, biodiversity, species, landscape, etc
• Rising ocean temperatures • More acidic oceans	• Fish habitat changes • Salinization of freshwater aquaculture/fish farms	• Shift in species distribution • Loss of marine and freshwater fish stocks • Increased vulnerability to intense fish stock exploitation • Loss of income for fishery workers	Fisheries sector loss/gain • Described as climate change impact on the value of fisheries sector exports

THE GREAT BARRIER REEF THREATENS TO TURN INTO A GARDEN OF SEAWEED AT JUST ONE MORE DEGREE OF WARMING

The economic stresses, as captured in this report, are by no means exhaustive. They reflect the limitations of the current research on economic impacts, particularly in the developing world.

Tourism is an example of a service sector industry that will be heavily affected by climate change but for which no established method exists to quantify the impact. And so the effect is not included here. Mountain ski resorts

and unique island paradises are nonetheless expected to be worst hit by rising heat and sea-levels. The world's largest coral sea, the Great Barrier Reef, which threatens to turn into a garden of seaweed at just one more degree of warming, could not be replaced as a tourist destination.[193] The effects will be worst in lower-income communities, such as for small island developing states including the Maldives, Mauritius, Seychelles, and dozens of other countries in the Caribbean and the Pacific.

There are other economic sectors dependent on natural conditions that will experience economic stress, but we have not measured those impacts here. Water supply, for example, will impact the agricultural processing industries (such as food processing, brewing, and textiles) and other industries with high water consumption (such as extractive industries and chemicals).[194] And transportation is likely to be increasingly disrupted as a result of extreme weather and the short-term costs linked to a potential shifting of trade routes.[195]

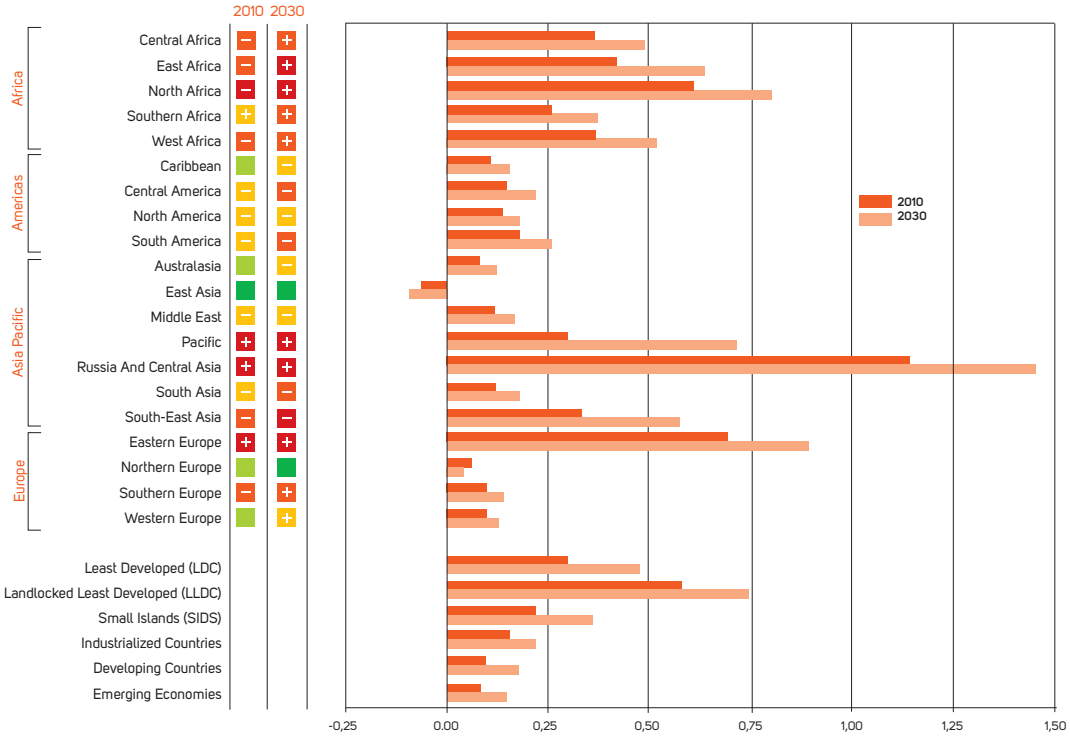
WHO SUFFERS?

The largest economic stress impacts by 2030 due to climate change are projected to be in Central Asia and Russia, and in Eastern Europe, the Pacific, and large parts of Africa. These are significant impacts of sometimes 1% or more of GDP in regions already plagued by the effects of water scarcity and challenging agricultural markets.

However, North Africa, regions of Sub-Saharan African, Pacific island states, and Southeast Asia also bear significant burdens of around 0.5% of GDP. While the absolute losses are much smaller, the human impact of economic stresses is likely to be felt acutely in regions that already suffer high rates of poverty and have very large vulnerable populations. Particularly in the somewhat longer term of 2050 and 2080, it is expected that South Asia and Sub-Saharan Africa will experience significant challenges due to falling crop yields because of rising temperatures.[196]

IMPACTS AROUND THE WORLD

The regional and socio-economic distribution of climate-related economic losses relative to gdp in 2010 and 2030
Additional Economic Losses (percent of GDP)



The countries projected to face the worst impacts of climate change are predominantly Pacific island states, due to negative impacts on fisheries in tropical waters, and Central Asian countries, due to loss of water resources.

The region most resilient to the economic stress impacts of climate change is Northern Europe. Denmark and Norway are the only countries projected to experience an improvement in gains over the period from today to 2030, progressing from Moderate to Low vulnerability. Iceland is also projected to retain Low vulnerability. These regions stand to benefit due to their high latitudes, where an increase in temperature is expected to benefit their fishery outputs, in particular.

East Asia, China, Mongolia, and North Korea are also projected to maintain a Monitor factor of Low due to overall economic stresses. However, these countries are projected to experience significant negative impacts in other areas. The overall positive economic stress impacts in these countries could mask significant negative effects in subregions of these countries.

The largest developed economies in the world, including the US, Japan, and Germany are among the worst affected in absolute terms. But large developing economies such as Russia, Brazil, and India, as well as Egypt in North Africa and Thailand and Indonesia in Southeast Asia also face significant burdens. Overall, the 10 countries bearing the largest burdens will collectively face 75% of economic losses in absolute terms.

THE 10 COUNTRIES BEARING THE LARGEST BURDENS WILL COLLECTIVELY FACE 75% OF ECONOMIC LOSSES

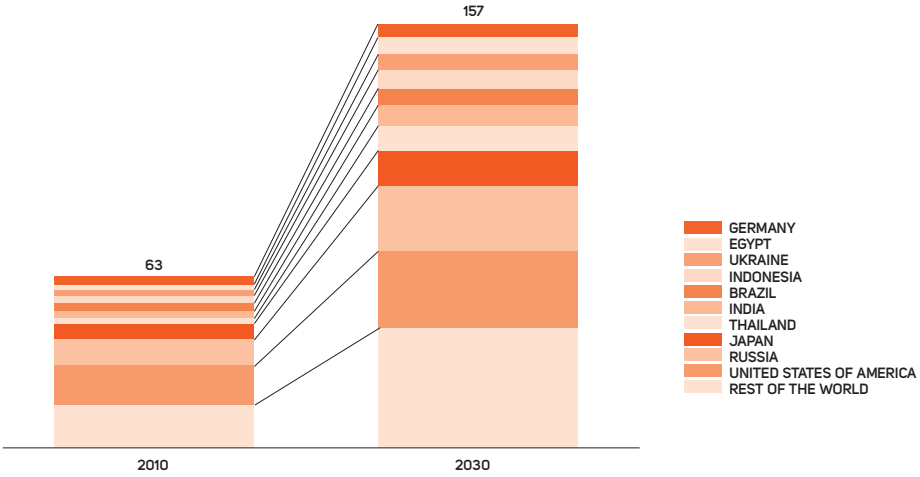
WORST HIT AND LEAST HIT (2030)

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

WORST	LEAST
VANUATU	ICELAND
SEYCHELLES	NORTH KOREA
MARSHALL ISLANDS	MONGOLIA
MALDIVES	CHINA
GEORGIA	NORWAY
KAZAKHSTAN	DENMARK
MOLDOVA	CYPRUS
TAJIKISTAN	SWEDEN
RUSSIA	MALTA
KYRGYZSTAN	SPAIN

HOTSPOTS: ECONOMIC LOSSES

Countries with the largest total climate-related economic losses
Additional Economic Losses (billion USD PPP)



THE IMPACT TOMORROW: 2030

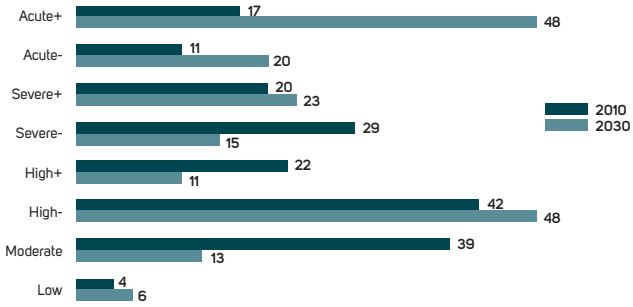
The three regions experiencing the fastest progression in economic stress impacts are the Pacific islands states and Southeast Asia, primarily due to negative impacts on fisheries, and Sub-Saharan African regions, particularly due to negative impacts on water supply.

The number of countries with Acute climate vulnerability factors more than doubles to almost 70 between 2010 and 2030. At the same time, a small number of countries are projected to experience an improvement from Moderate to Low vulnerability.

VULNERABILITY SHIFT

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

Number of Countries by Vulnerability Factor

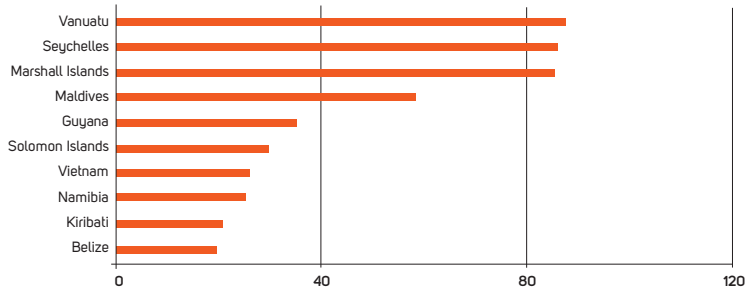


Small island developing states like Maldives, Marshall Islands, Seychelles, and Vanuatu all face fast progressions in economic losses. This is also the case for Vietnam in Southeast Asia and for Namibia in Southern Africa. Negative impacts on fisheries play an important role in the acceleration of negative impacts for these countries between 2010 and 2030.

HIGH SURGE VULNERABILITY

Countries with the fastest growing climate-related economic losses between 2010 and 2030

Percentage increase in climate-related economic losses



SPOTLIGHT: SUPER DROUGHT

Many of the worst types of climate change impacts come from the synergistic interaction between existing degradation or depletion of natural resources and shifts in climate that reinforce these. Depleted water stocks, rainfall changes, heat, drought, and the agricultural and human consequences of these combined effects form danger-prone environment in poorer communities where resource management is insufficient. Northern India, for example, is generally becoming drier due to shifts in the Indian monsoon in areas where water resources are increasingly scarce as a result of non-sustainable pumping of groundwater.[197] The combination of unsustainable resource use and climate stress on the resource could lead to super-droughts with potentially catastrophic human and ecosystem impacts for the region.

India is home to about 16% of the global population but has only 4% of the total water resources, with the irrigation sector consuming 83% of India's. The main water source of water replenishment in India consists of precipitation within Indian territory.[198]

In 2009, the poor monsoon season caused severe drought impacts in 40% of districts. The northwestern and northeastern parts of the country were worst affected amid one of the weakest monsoon seasons for almost 40 years.[199]

Between August 2002 and October 2008, three northwest Indian states lost a volume of water from underground supplies equal to more than twice the capacity of Lake Mead (1 1/4 trillion cubic feet of water), the US's largest reservoir.[200] Evidence points to the pumping of water from wells for irrigation as highly damaging to India's resources. Without measures to curb demand, further climate stresses on dwindling groundwater supplies could cause serious drinking-water shortages and erode crop production in a region inhabited by over 100 million people.[201]

THE ASSESSMENT

The Economic Stress impact area is calculated by using a set of variables indicating the projected economic losses in different sectors as a share of GDP due to climate change. Estimates for four economic sectors are based on the FUND (2.8n) model.[202] The model links exogenous population and per capita income scenarios with simple models of technology, economics, emissions, atmospheric chemistry, climate and sea-levels in order to estimate impacts such as migration, disease burdens and economic effects on a sector basis.

In addition to reliance of FUND, economic losses in fisheries are calculated using Cheung et al. 2010 estimates.[203] Cheung et al. estimate the change in maximum catch potential due to climate change.

FUND offers national level economic loss estimates but many of its parameters are at the level of 16 regions meaning country effects encapsulate the average effect across a sub-region leading to inaccurate assessment results. For instance, Spain (High-/High-) is an example of a country that we expect to be worse impacted than Western Europe -- its model home sub-region, one also incorporating Northern Europe. Spain is affected in relation to water resources, an anticipated increase in temperatures (and plant evapotranspiration) and a decrease in rainfall, by 5%-10% to up to 20%-22% by the end of the 21st century.[204] Northern Europe on the other hand may be set to gain in agricultural production due to climate change.[205]

The Baltic states (Acute+/Acute+) are examples of countries that we expect to be less impacted than countries from the former Soviet Union on average.

The key variable driving the findings on economic stress are water resources. A large part of the water resources impact concerns the agricultural sector, although other key sectors drawing heavily on water are also concerned.

The finding that stands out from the model is that Central Asia, Russia and Eastern Europe face significant water resources impacts.[206] This includes for example Russia (Acute+/Acute+), Kazakhstan (Acute+/Acute+) and Poland (Severe+/Acute-). The key explanation for this is that these regions have continental climates (as opposed to coastal). They are projected to face high temperature rises and their water resources are sensitive to the changes (particularly due to “evapotranspiration”).

Countries in South Asia on the other hand stand out for relatively low vulnerability, for example Afghanistan (Moderate/High-), India (High-/High-) and Pakistan (High-/High-) regardless of expected continued high temperatures. These countries bear a high health burden among children due to causes related to nutrition and water access. They are also projected to be among the hardest-hit by declining crop yields in the longer term.[207]

The key to understanding why the Economic Stress assesses only a Moderate/High factor to the South Asian countries is that the worst impacts globally in the near term (our 2010/2030) are related to water resources rather than temperature. The majority of South Asia is not expected to suffer significant water stresses as a result of climate change -- although major water stress issues prevail for other reasons. Shifts in precipitation/evaporation/river flows drive the “early” results, while projected temperature impacts on yields follow by 2050/2080, since water impacts have a proportionally higher impact on agricultural yields for instance than higher temperatures. This is why Central Asia/Russia and North Africa experience impacts sooner than South Asia.[208]

A number of Small Island States, such as the Maldives (Severe-/Severe+), the Marshall Islands (Acute-/Acute+) and other Pacific countries are to be found near the top of the list due to fisheries impacts, in particular related to the expected destruction of coral reefs, which are much more moderate for instance for the rest of South Asia.

Division and Wall Street in Colfax, Iowa in August 2010. Waters are receding from record flooding. Source: FEMA/Jace Anderson.