METHODOLOGY

ARCHITECTURE

FOUNDATIONS

In all, the Monitor comprises 34 indicators of the economic, human and ecological effects of climate change and the carbon economy. Indexes form the backbone of each indicator and are responsible for generating the relative level of vulnerability registered for each country.

Each index is determined exclusively on the basis of mortality and/or GDP per capita data, capturing only the climate change or carbon economy effect in isolation from other factors. In order to support fair socio-economic comparisons between countries, all estimates are made either in monetary terms (GDP losses) or in terms of mortality. Indicators in the Climate Environmental Disasters impact area are the only ones to combine both mortality and GDP per capita in order to determine the Monitor vulnerability level, where both variables are given full weighting. Combining the variables in this instance ensures a holistic interpretation of the full socio-economic spectrum of disaster vulnerability and does not seek to imply any value judgement on human life versus inanimate assets. Mortality, in many cases, might be fewer than 10 deaths per 10 million, so the smallest countries may not register vulnerability to extreme weather if economic losses are not accounted for. Additional variables of interest are provided for different indicators as appropriate in order to provide a fuller understanding of the impacts estimated to be taking place, such as populations at risk from desertification or illness rates for health indicators.

BREADTH AND AGGREGATION

The Monitor uses an enumerative methodology to estimate a wide range of distinct effects resulting from climate change and the carbon economy that can be summed to gauge overall country and global impacts in socio-economic terms. Each indicator represents a separate grouped set of effects that rely on independent research and data sets. All effects are unified by means of a common mathematical framework and assimilated into indexes that facilitate comparison and analysis between the 184 countries.

IMPACT ESTIMATIONS

Each of the Monitor's 34 indicators provides cost or gain estimates for 2010 and 2030 that relate solely to climate change or the carbon economy. They are the results of this project's particular methodology and the underlying research and data sets chosen. Other choices, other methodologies and other projects will almost certainly yield different results. Ideally, comparable efforts by other research groups would help identify more readily the main areas of confluence and incongruence between the different findings and approaches that now exist.

VULNERABILITY LEVELS

The Monitor's vulnerability assessment system enables a comparison of impacts on a per capita basis across countries. The level of impact indicates the level of climate-related vulnerability. The five vulnerability levels used throughout the Monitor are statistically determined via (mean absolute) standard deviation, with the level "Low" representing near-zero or positive effects and the level "Acute" denoting impacts several degrees or intervals removed from (or above) Low.
The upper three levels of vulnerability (Acute, Severe, High) also have two further sub-categories that are sometimes shown to illustrate where (at the top or low end) in these higher vulnerability categories the assessment places countries or groups. Vulnerability levels are determined for each indicator in relation to how all countries are collectively experiencing that particular effect. This is done at the effect level – Sea-Level Rise, for instance. So in some cases, effects for which a country has Acute vulnerability may be smaller in scale than concerns assessed at High vulnerability. Vulnerability levels indicate a country's deviation from the norm of impacts experienced for a given effect and do not necessarily indicate which effects present the highest risk to a country.
Aggregated indexes for the Climate and Carbon sections are determined by averaging or adding up the results of the lower tier assessments. Multi-dimensional vulnerability to Climate or Carbon is an average across all indexes and is only representative

of the degree to which countries are vulnerable to a wide range of effects, without considering the relative importance of different effects. The overall human (or mortality) impact or the overall economic impact data (indexes) on the other hand, represent the sum of all effects measured in the lower tiers and illustrate how these totals compare with other countries. The vulnerability levels are static so that progression of effects over time highlights the degree to which countries are estimated to be gaining or shedding vulnerability between 2010 and 2030. The whole statistical framework is an attempt to conserve the implications of the underlying scientific/research estimations, which are cited, together with key data, in the chapters for each indicator.

CALCULATING CLIMATE AND CARBON EFFECTS

To calculate the impact of individual effects, the Monitor combines estimations from expert and scientific literature or models with bodies of ecological, economic or societal data. It is assumed that the impacts of climate change and the carbon economy are already at play in the world's economic, environmental and social systems. Therefore, to estimate the impact of either process, "climate" or "carbon", on current levels of welfare, it is necessary to keep a counterfactual in mind. The counterfactual is the situation that would have prevailed in the absence of climate change and/or carbon intensive practices. Incremental economic, environmental or social outcomes assessed here are therefore estimated deviations from a level of welfare that would otherwise have been higher or lower. Any opportunity costs only make sense if an alternative to the carbon economy is available. Therefore, costs and benefits must be contextualized against the costs of transitioning towards a low-carbon economy – for which analysis is provided at the front of this report.

CONTEXTUAL BASES

The Monitor's system of analysis relies on reference projections in order to generate the most plausible understanding of how the world is likely to evolve between now and 2030. GHG emissions and temperature increases vary across indicators depending on the base research, with the most common scenario being the medium-high A1B marker scenario of the IPCC (IPCC, 2000). Climate change is understood as the change in weather versus, in most cases, a base year of 1975 (as the mid-point of the 1961 to 1990 climate). Projections for population and economic growth are drawn from Columbia University's Centre for International Earth Science Information Network based on the IPCC A1B scenario (CIESIN, 2002). Reference GDP and population data is drawn respectively from the International Monetary Fund and the UN population division (IMF WEO, 2012; UN pop div., 2012). For certain indicators other dynamic adjustments are made to key parameters, such as an anticipated income-driven decline in the prevalence of some communicable diseases, or structural evolutions to developing economies (Mathers and Loncar, 2005; OCED, 2012). Current responses to climate change, such as adaptation or mitigation, are assumed to be held at today's relative levels so that estimates for 2030 represent business as usual. The Monitor doesn't adjust for any future policy initiatives that could increase or stimulate adaptation to or mitigation of climate change.

THE APPROACH

DEALING WITH CLIMATE UNCERTAINTIES

The Monitor is a pragmatic study. Exercises like the Monitor are by definition imperfect (Smith et al. in IPCC, 2001), above all because a variety of uncertainties exist in almost every tier of the analysis. There are six main sets of uncertainties involved in the Monitor's assessment:

- *Climate-related:* uncertainty about the levels of GHG emissions (present and future), temperature changes for different emission levels, effects for other weather variables such as wind and rainfall as a result of temperature changes, limitations of global or regional research (i.e. climate models) accurately describing effects at country or sub-national levels
- *Social and environmental:* uncertainty related to the varying quality or comprehensiveness of the base data, such as the accuracy of databases on current rates of illness, of reported disaster damage

MISSING THE FULL METHODOLOGICAL DOCUMENTATION?

The complete in-depth methodological documentation for the Monitor with technical descriptions for each of its indicators is available online at:
www.dararint.org/cvm2/method

or of biodiversity concentrations and projections of population growth

- *Economic/technological:* uncertainty related to future economic growth and advances in technology
- *Scientific/empirical:* uncertainty in estimating the effects of climate change in social, economic or ecological terms
- *Extrapolation:* in many cases, effects are estimated in just a few representative countries and are then extrapolated to provide a global picture, introducing possibilities for error
- *Aggregation/assimilation:* when compiling diverse data sets, models and pieces of information, judgements of different kinds sometimes must be made, which could introduce further margins of error.

Many of the above factors are closely interrelated, such as population, economic growth and emissions of GHGs.

Uncertainty is, therefore, very real to the study of climate change and must be taken seriously. However, the world cannot simply wait, inactive, until all uncertainties have been mathematically weighed even as climate changes are clearly observable as recorded in successive IPCC reports (IPCC, 1990, 1995, 2001 and 2007). The uncertainty of this study is also relatively contained for the field of climate change, given the short timeframe of much of the analysis compared to the near centennial or longer focus of most climate research. Neither is uncertainty restricted to the field of climate change. Major macroeconomic and corporate decisions are made every day, shaping global and local economies around the world that involve the highest degrees of uncertainty (Oxelheim and Wihlborg, 2008).

Studies like this one make best attempts to soundly balance all of the competing considerations. Deliberate steps are also taken to minimize uncertainties. For instance, the database of economic damage caused by extreme storms and floods that the Monitor uses is a hybrid of the main international provider in the public sector and one of the main global reinsurers (CRED/EM-DAT, 2012; Munich Re NatCat, 2012). Relying on just one of these reduces considerably the losses for several countries, decreasing the robustness of any conclusions.

On the other hand, the homogeneity of more than 15 models in predicting large increases in heavy rainfall as the planet warms is quite striking, considering many of them were developed separately by experts living in different countries over varying periods of time (Kharin et al., 2007; IPCC, 2012a).

That so much research in this field reaches similar conclusions is remarkable precisely because of the implausibly large uncertainties that apply. The “unequivocal” language of the IPCC regarding the existence and primary causes of recent global warming is a good example (IPCC, 2007). It results from an overwhelming burden of proof with no alternative explanations (Royal Society, 2005). And it explains why the leading scientific bodies of more than 50 countries, including those of major economies like the US and China, regularly communicate concern on climate change issues (IAP, 2009).

While there’s now clear consensus on the basics of climate change, the similar findings that result from similar assumptions from study to study do leave the door open to systemic risk. This could prevent anticipation of catastrophic outcomes. The economics field met with such a crisis following the collapse of the global financial system in 2008 (Krugman, 2009). Unlike business-cycle decisions, decisions on the climate do not leave as much scope for error and recuperation if full heed is paid to the conclusions of mainstream science and GHG emission modelling (IPCC, 2007; UNEP, 2011).

Experts say that, when making decisions in highly dynamic and uncertain conditions, those decisions should be robust to a wide range of possible outcomes, should involve learning for improved reactions to emerging risks and opportunities, and should be grounded in a wide range of analytical inputs so as not to exclude potentially important options or concerns (Lempert and Schlesinger, 2000; Vecchiato, 2012; Baddeley, 2010). This study offers just one further input to that process.

PRECAUTIONARY MEASURES

The 1992 UN climate change convention (UNFCCC), the key international treaty on climate change, does stipulate precaution and binds its 195 parties to take cost-effective measures to prevent or minimize harm

COMMENTS AND SUGGESTIONS

Readers, specialists and users of the report are highly encouraged to forward any suggestions for improvements to the structure, focus and/or methodology of the Monitor to DARA. The research team is most grateful for every input received. Please contact DARA via: **cvm@daraint.org**

when threats of serious or irreversible damage are evident – even in the absence of full scientific certainty (UNFCCC, 1992).

The conclusions offered by this report point to serious harm. The findings are, however, based on estimates that could, in reality, be either substantially lower or substantially higher – as uncertainty is symmetrical. Caution, though, is particularly flagged because the Monitor's approach is less precautionary than it is conservative in several respects.

LIMITATIONS OF ANALYSIS

To begin with, the emission scenario chosen for most indicators is not the highest available. While the second edition of the Monitor is significantly more comprehensive than the first, numerous impacts are simply beyond the analysis here for lack of adequate reference studies or due to methodological difficulties.

This particularly applies to so-called "socially contingent" impacts, such as the effects on social and political stability, conflict, crime, or cultural assets, such as World Heritage sites – for which plausible relationships have been mapped or argued (Stern, 2006; Ahmed et al., 2009; Burke et al., 2009 and 2010; CNA, 2007; Scheffran et al., 2012; Agnew, 2012; UNESCO, 2010). Neither does the mainly near-term Monitor factor in the potential costs of future large-scale abrupt impacts, although a number of prominent economists whose timeframes of analysis are more extended advise otherwise (Nordaus and Boyer, 2000; Hope, 2006). Still, it is equally possible that some of the impacts not considered here include positive outcomes for society (Tol, 2010).

Other more straightforward costs that are known lacunas for the field are also not adequately covered here. Agriculture is just one example. Costs associated with additional irrigation by farmers in a much warmer world are essentially unaccounted for in most agricultural models, even when high temperatures are expected to more than offset any additional rainfall (Cline, 2007). Furthermore, a broad range of staple crops are now understood to react more rapidly and negatively after exceeding a particular high temperature threshold than was previously understood to be the case (Schlenker and Roberts, 2009; Ackerman and Stanton, 2011).

Finally, this study uses the equivalent of a direct-cost approach for estimations, exploring impacts as losses or gains to independent sectors or as discrete gains/losses for those directly affected. This does not take into consideration the passing on of gains or losses elsewhere. It is, however, generally understood that markets can and do spread these effects further. Businesses for instance, pass on their prosperity or difficulties to their clients, competitors and suppliers, as well as to investors and financial markets (Kuik et al., 2008). That fact has led some experts to conclude that direct costs are, by definition, an underestimation (Bosello et al., 2005). One expert has estimated that direct damage costs could be multiplied by a factor of 20 in certain instances (Hallegatte, 2005).

Balancing Comprehensiveness and Accuracy

The Monitor attempts to contribute breadth and descriptiveness to the understanding of global climate-related issues without venturing too far into conjecture and methodological unknowns. Although the spectrum of over 30 indicators reviewed does range from the clearly speculative through to the more robust. The larger-scale impacts assessed in the Monitor are nevertheless evaluated as being more robust in general than the impacts of lesser macroeconomic significance also included here.

Even when knowledge barriers allow for little more than speculation on the full nature of an effect, it was judged that not including these effects, such as tropical storms or impacts on the tourism industry – indicators endowed respectively with high uncertainty and low scientific foundations – would penalize the assessment more through a lack of comprehensiveness than might be gained through any enhanced certitude.

Uncertainties, once more, are fundamental to any understanding and response to climate change. As global warming accelerates, everyone from policy makers through to the general public will likely be required to engage and act more on the basis of uncertain and speculative information. Given the stage of development of climate policy, deliberately highlighting limitations within studies like this through inclusion of potentially vital information (while clearly signalling its shortcomings) can serve to shed light on how and where limitations lie, aid in pinpointing research priorities and provide greater clarity in separating out the less robust information from the more robust. This report aims to advance understanding in all such respects.

ASSESSMENT CATEGORIZATION/DISTINCTIONS

OVERLAP AND SEPARATING EFFECTS

A very deliberate effort has been made to ensure that all indicators in the Monitor represent no – or at worst only marginal or statistically insignificant – overlap. The Climate Environmental Disasters indicator on drought is a case in point. Unlike the other disaster indicators, it does not account for any mortality impact. This is because the Hunger indicator under Health Impact is accounting for the ramifications of worsening food availability as a result of climate change, including drought. Another example relates to the Sea-Level Rise and Water indicators under Climate Habitat Change. The Water indicator measures the impact of a net change in water availability resulting from rainfall pattern alterations and heat. It does not, however, account for the saline contamination of water reservoirs in coastal areas caused by erosion due to rising sea levels, an effect captured under the Sea-Level Rise indicator.

Furthermore, two indicators, Heating and Cooling and Labour Productivity, both categorized under Climate Habitat Change, are near mirrors to one another and required adjustment to avoid overlap. Heating and Cooling estimates the rising or falling energy costs linked to the climate conditioning of indoor space to maintain unaltered levels of comfort as the planet warms. Labour Productivity measures the losses (or gains) to productivity incurred to the outdoor and indoor workforce exposed to increasing heat. The costs estimated in Heating and Cooling were removed from the Labour Productivity indicator to ensure no overlap.

The Carbon section is generally more clear-cut than the Climate section, which assesses almost double the number of effects. The greatest propensity for overlap concerns the Climate indicators for Agriculture, Desertification, Drought and Water, although the extent of this is still considered limited. This is because the Agriculture indicator is mainly measuring a departure from optimal growing conditions or how land value and production capacity evolve in relation to changing climate conditions, whereas Drought is estimating the implications – mainly for the agricultural sector – of the increasing occurrence of these major hydrological events, which are highly randomized and have severe repercussions that are not fully accounted for in climate productivity models of agricultural yield change. Desertification very specifically measures the highly accelerated degradation of arid lands due to heat and water stress and the associated depreciation of land investments and yield capacity. There is, however, some possibility of overlap due to the manner in which the land-value base estimates for agricultural losses are calculated as a component of the Monitor's Climate Agriculture indicator (see: Cline, 2007). As Desertification itself represents just 1% of estimated global losses due to climate change in 2010, any overlap would still be quite marginal to this study.

Rainfall and evaporation are other parameters built into the Agriculture indicator. Less favourable rainfall patterns or high levels of evaporation not compensated for by additional rain will invariably entail losses, especially for rain-fed only agriculture, some of which are certainly accounted for under the Agriculture indicator. The Drought indicator also measures farm losses due to extreme water scarcity. Independent from this, the Water indicator measures national variation in the water resource balance sheet and assumes that deficits due to climate change are made up at the lowest market price for water.

Where agriculture is rain-fed only, there is no overlap, since such farmers are not purchasing water on the market and are therefore not accounted for in water demand estimations. Where farmers rely on supplied irrigation, deviations from optimal conditions likely cause demand for water to increase as the farmer pays for the additional requirement (and incurs a cost). Alternatively, more water may not be purchased and yield losses could result (also incurring costs). But what the Water indicator measures is the overall change in supply to the market that the farmer purchases water from. It assumes that in order to maintain the same supply of water that existed prior to the onset of unfavourable conditions, costs will be incurred at the market rate for supplying more water.

That means it is accounting for the cost of retaining equilibrium market conditions to offset any scarcity at the time when the farmer is purchasing additional water. Of course, if the entire agricultural sector is purchasing more water, demand will also increase and so will the market price and the losses for the sector. Such intricacies can rarely be accounted for in agriculture models such as those the Monitor draws on for that indicator (Cline, 2007). Therefore, any overlap is largely contained.

CARBON: CONCEPTUAL FRAMEWORK

The new Monitor now supplements analysis with a detailed assessment of the economic, health and environmental impacts of the carbon economy.
This assessment forms the second part of the Monitor, labelled “Carbon”. Of special interest in the Carbon part of the Monitor is the acquisition and consumption of fuels and the release of various types of greenhouse pollutants via combustion. The Monitor examines the costs and benefits of all these processes – extraction, production, consumption – independently of the wide-ranging costs and benefits resulting from climate change, which, of course, is caused by these processes.

It is important to qualify three points related to the Carbon section. First, highly hazardous sulphur dioxide emissions are included in the analysis, although strictly speaking, sulphur is not a GHG and is even widely understood to have cooling, rather than warming, properties (Kaufmann et al., 2011; Smith et al., 2011). Other research, however, has asserted that sulphur is a principal initiator of global warming since it decreases the atmosphere’s capacity to oxidize and deplete GHGs (Ward, 2009). Either way, sulphur dioxide is typically emitted together with other GHGs in transportation and energy production – coal power, in particular, which is also responsible for 40% of CO_2 emissions – and various mitigation policies targeting these gases would in most instances implicate sulphur dioxide as well (Olivier et al., 2012). Hence sulphur emissions go hand in hand with a carbon economy and are largely incompatible with a low-carbon economy.

Second, when the Monitor discusses urban air pollution and indoor smoke concerns for human health, it includes the burning of biomass (e.g. wood, crop waste), especially in open or indoor fires, which may not necessarily contribute to global warming if the source of fuel is self-replenishing (such as crop waste). With nearly 3 billion people relying on traditional stoves for household needs worldwide, however, particulate-generating cooking stoves are still considered a major source of GHGs and, especially in arid countries with low biomass availability, can drive deforestation (Foell et al., 2011; Bensch and Peters, 2011). The burning of biomass, including in indoor settings, is in any case understood as a principal driver of current warming due to concentrated emissions of soot in highly populated tropical regions (Ramanathan and Carmichael, 2008). Measures to furnish clean burning stoves to households would also enhance GHG sinks. The Monitor did not, therefore, exclude this issue from the analysis.

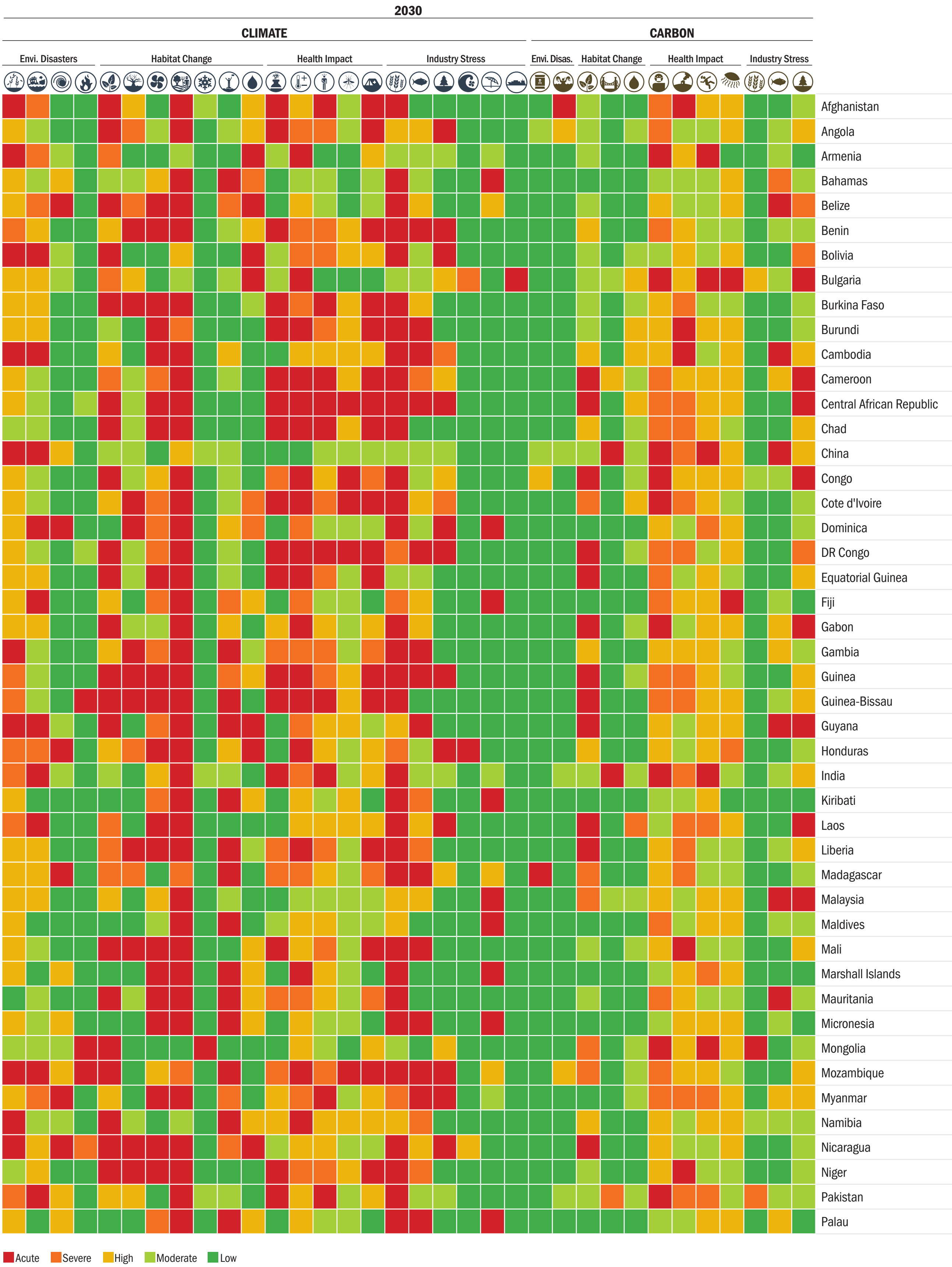
The third issue relates to carbon fertilization, which is a phenomenon measured in the Carbon section (see: Carbon/Agriculture). However, the Hunger indicator in the Climate section (see: Climate/Hunger) nevertheless accounts for the positive role that carbon fertilization can play in reducing the degree of agricultural losses on the basis of a World Health Organization model (WHO, 2004).

DATA TABLES

ACUTE

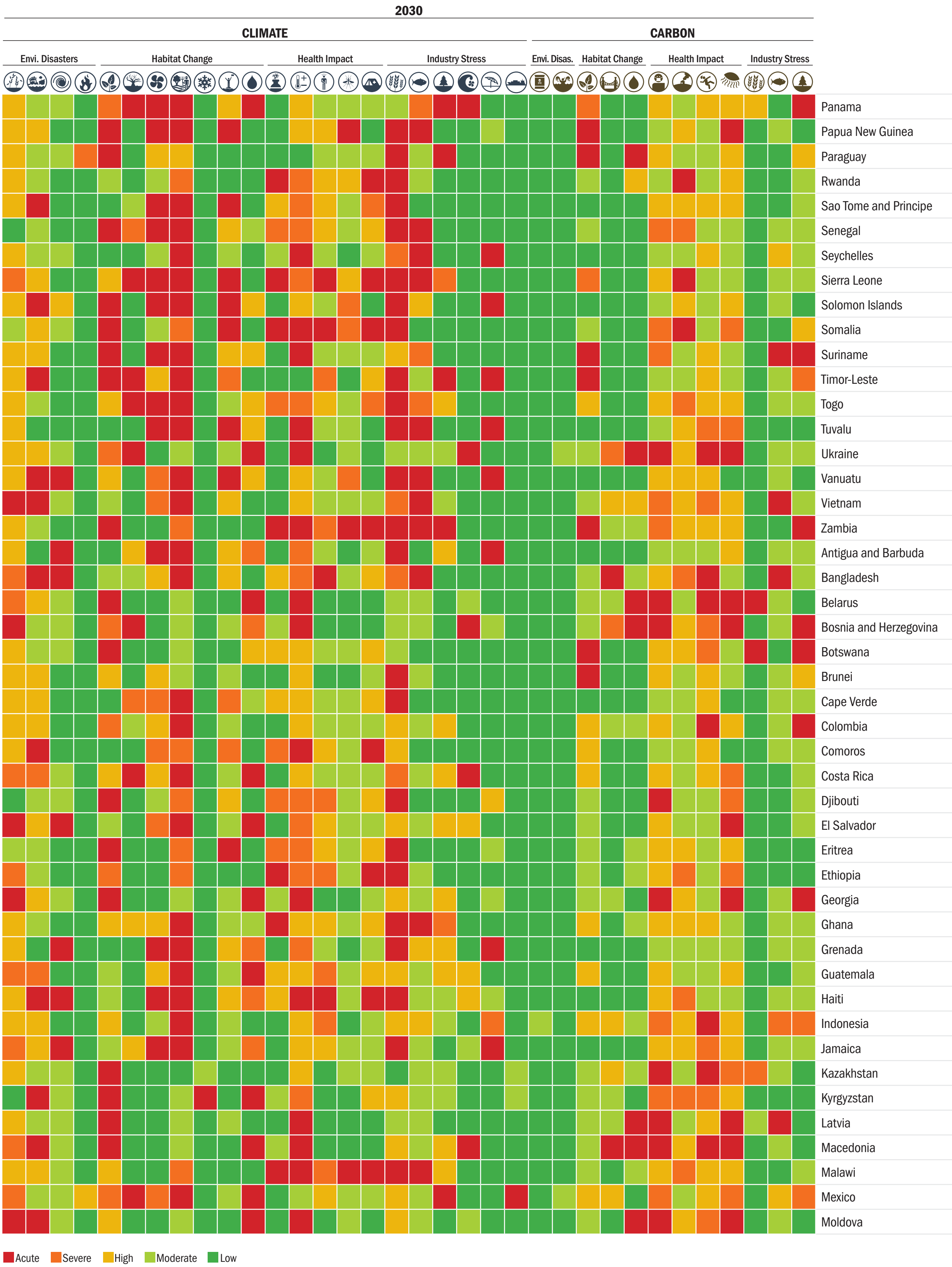
Country	TOTAL 2010	TOTAL 2030	1,000s 2010	1,000s 2030	% GDP PPP 2010	% GDP PPP 2030	% GDP PPP 2010
Afghanistan	90,000	150,000	10,000	20,000	2.8%	4.9%	5.5%
Angola	45,000	45,000	10,000	15,000	4.1%	7.9%	9.2%
Armenia	3,000	3,000	95	95	0.6%	1.2%	0.5%
Bahamas	30	35	95	100	5.8%	15.8%	
Belize	45	55	30	40	7.7%	14.2%	5.3%
Benin	9,000	9,500	1,250	1,750	5.0%	10.2%	2.7%
Bolivia	3,000	3,500	1,000	1,500	3.3%	7.5%	8.8%
Bulgaria	7,000	6,000	85	80	0.7%	1.5%	0.7%
Burkina Faso	25,000	30,000	3,250	3,750	4.5%	8.6%	3.0%
Burundi	15,000	15,000	1,500	2,000	3.9%	8.7%	3.5%
Cambodia	15,000	20,000	1,750	2,000	4.9%	10.3%	2.7%
Cameroon	20,000	20,000	4,000	5,000	4.4%	9.0%	4.3%
Central African Republic	5,500	5,500	650	900	5.6%	11.9%	13.5%
Chad	20,000	20,000	2,500	3,000	5.0%	9.5%	3.1%
China	1,500,000	1,500,000	100,000	100,000	0.7%	1.3%	0.7%
Congo	3,500	4,500	450	650	3.4%	6.5%	8.0%
Cote d'Ivoire	25,000	25,000	2,250	3,250	4.6%	8.9%	3.7%
Dominica	15	15	60	80	5.9%	11.7%	0.1%
DR Congo	100,000	100,000	15,000	20,000	3.9%	8.5%	7.1%
Equatorial Guinea	250	350	250	350	3.1%	5.8%	5.0%
Fiji	300	300	95	95	6.2%	11.1%	0.2%
Gabon	700	950	250	350	5.8%	11.1%	23.1%
Gambia	1,500	1,000	250	300	9.0%	18.2%	1.7%
Guinea	10,000	10,000	1,250	1,500	8.0%	16.3%	4.3%
Guinea-Bissau	2,500	2,500	450	600	27.4%	47.2%	5.9%
Guyana	250	200	150	200	7.4%	12.6%	40.5%
Honduras	2,500	3,000	350	650	4.6%	9.0%	1.5%
India	1,000,000	1,500,000	250,000	450,000	2.2%	4.3%	1.0%
Kiribati	15	20	85	95	17.4%	28.1%	0.1%
Laos	4,000	4,500	650	800	3.5%	7.1%	3.0%
Liberia	6,000	7,000	600	700	9.9%	17.5%	6.1%
Madagascar	20,000	20,000	2,250	2,750	6.8%	11.8%	3.1%
Malaysia	5,500	8,000	2,750	3,250	3.6%	7.3%	2.2%
Maldives	70	150	250	350	9.2%	15.9%	0.2%
Mali	25,000	25,000	3,000	3,500	5.7%	11.9%	3.3%
Marshall Islands	30	35	55	60	31.3%	49.6%	0.4%
Mauritania	3,500	3,500	350	400	9.0%	16.6%	1.4%
Micronesia	30	35	20	25	10.3%	20.7%	0.3%
Mongolia	1,500	1,500	600	1,250	6.5%	8.4%	1.9%
Mozambique	25,000	25,000	6,000	8,500	7.7%	14.2%	3.6%
Myanmar	45,000	55,000	10,000	15,000	6.6%	12.9%	0.8%
Namibia	450	550	150	250	1.4%	13.5%	1.2%
Nicaragua	1,500	2,000	200	400	6.3%	11.8%	2.4%
Niger	35,000	40,000	4,000	4,500	5.3%	10.0%	4.9%
Pakistan	150,000	250,000	20,000	45,000	2.3%	4.4%	1.0%
Palau	5	5	5	5	8.6%	15.2%	0.1%

Additional mortality – yearly average
Additional economic costs in 2010 USD (negative numbers show gains) – yearly average
Additional persons affected – yearly average


2030
CLIMATE
CARBON
Envi. Disasters
Habitat Change
Health Impact
Industry Stress
Envi. Disas.
Habitat Change
Health Impact
Industry Stress
Afghanistan
Angola
Armenia
Bahamas
Belize
Benin
Bolivia
Bulgaria
Burkina Faso
Burundi
Cambodia
Cameroon
Central African Republic
Chad
China
Congo
Cote d'Ivoire
Dominica
DR Congo
Equatorial Guinea
Fiji
Gabon
Gambia
Guinea
Guinea-Bissau
Guyana
Honduras
India
Kiribati
Laos
Liberia
Madagascar
Malaysia
Maldives
Mali
Marshall Islands
Mauritania
Micronesia
Mongolia
Mozambique
Myanmar
Namibia
Nicaragua
Niger
Pakistan
Palau
Acute
Severe
High
Moderate
Low

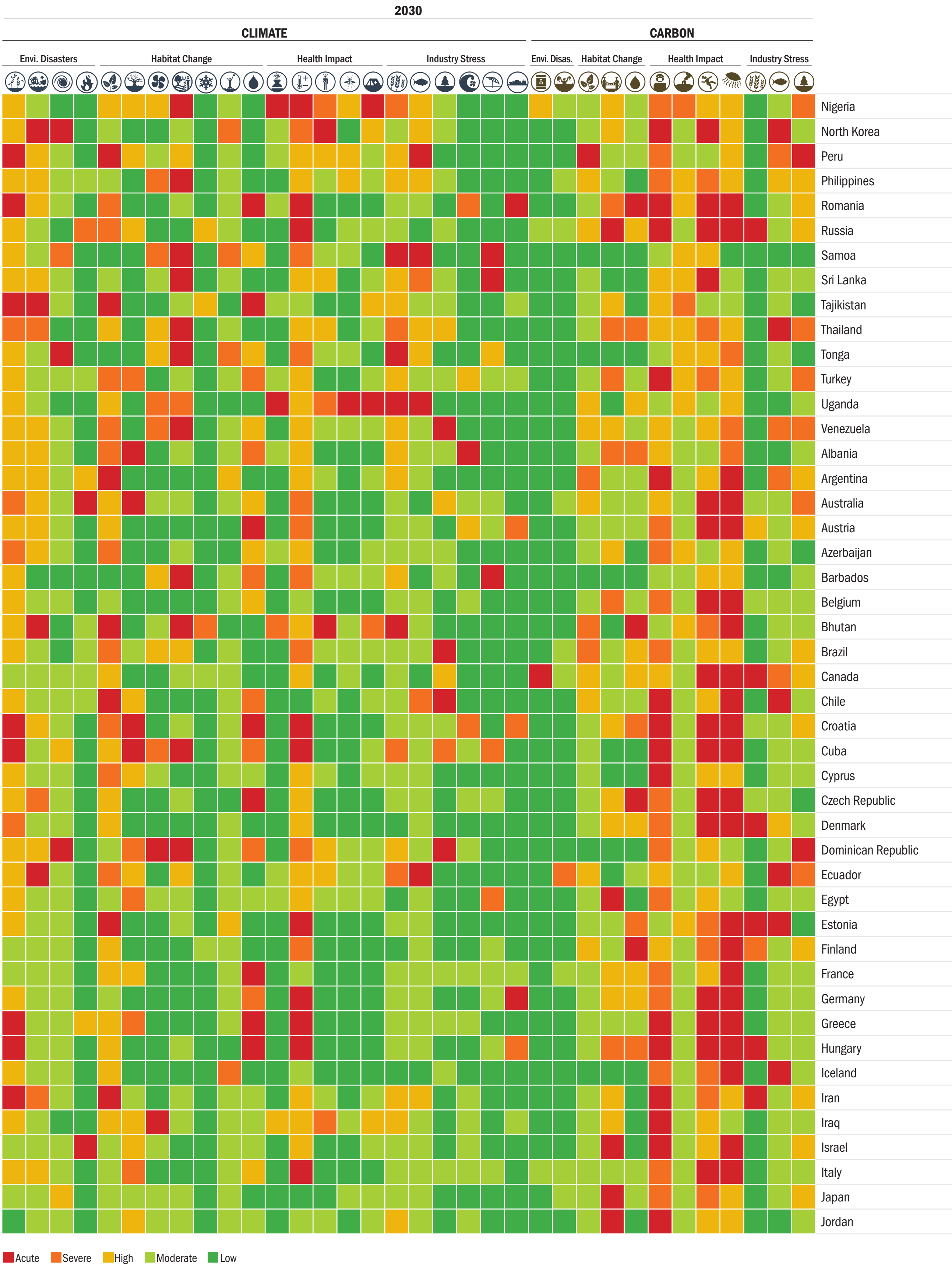
Group	Country	TOTAL 2010	TOTAL 2030	1,000s 2010	1,000s 2030	% GDP PPP 2010	% GDP PPP 2030	% GDP PPP 2010
ACUTE	Panama	550	650	250	400	4.2%	8.4%	2.1%
	Papua New Guinea	3,500	5,000	850	1,500	6.6%	12.1%	11.6%
	Paraguay	1,000	1,500	150	250	1.3%	3.0%	4.7%
	Rwanda	20,000	15,000	1,500	2,000	2.4%	4.5%	3.6%
	Sao Tome and Principe	100	100	20	35	9.1%	15.8%	1.3%
	Senegal	15,000	15,000	1,500	2,000	6.2%	12.3%	1.9%
	Seychelles	10	10	20	30	8.1%	19.1%	
	Sierra Leone	15,000	15,000	1,500	1,750	10.4%	20.5%	7.4%
	Solomon Islands	200	250	100	150	21.1%	34.1%	0.4%
	Somalia	20,000	20,000	3,000	4,000	16.7%	25.9%	3.4%
	Suriname	150	150	90	100	4.0%	7.2%	25.1%
	Timor-Leste	250	250	150	200	8.7%	16.0%	5.8%
	Togo	7,500	7,000	700	1,000	5.1%	10.2%	2.5%
	Tuvalu	5	5	10	10	11.0%	23.1%	0.4%
	Ukraine	45,000	40,000	3,250	4,000	0.8%	1.4%	0.4%
	Vanuatu	75	100	35	50	21.1%	44.8%	0.2%
	Vietnam	55,000	65,000	20,000	25,000	5.2%	10.7%	0.8%
	Zambia	15,000	15,000	1,750	2,250	3.1%	7.1%	5.2%
SEVERE	Antigua and Barbuda	10	10	60	75	5.1%	10.6%	0.1%
	Bangladesh	100,000	150,000	55,000	70,000	2.8%	6.8%	0.9%
	Belarus	5,500	5,500	100	150	0.7%	1.2%	0.7%
	Bosnia and Herzegovina	3,000	3,000	150	300	0.5%	1.0%	0.5%
	Botswana	1,000	850	200	250	0.9%	1.5%	3.3%
	Brunei	35	55	100	150	0.5%	0.7%	3.5%
	Cape Verde	90	85	85	150	5.8%	10.6%	0.2%
	Colombia	10,000	15,000	1,250	2,000	2.6%	5.2%	1.5%
	Comoros	300	300	90	95	4.5%	7.5%	0.9%
	Costa Rica	700	850	100	200	3.1%	6.3%	0.6%
	Djibouti	550	600	200	300	3.6%	6.6%	0.4%
	El Salvador	1,500	1,500	300	500	3.6%	7.2%	0.5%
	Eritrea	3,000	3,000	300	450	5.2%	8.6%	1.3%
	Ethiopia	100,000	100,000	10,000	15,000	2.0%	3.7%	2.7%
	Georgia	3,500	3,500	150	150	1.5%	2.9%	0.7%
	Ghana	15,000	15,000	2,250	2,750	4.4%	8.9%	1.7%
	Grenada	10	10	25	30	5.2%	10.3%	0.1%
	Guatemala	3,500	5,000	1,750	2,500	2.9%	5.8%	0.8%
	Haiti	8,000	9,000	1,500	1,750	3.7%	7.1%	1.2%
	Indonesia	150,000	200,000	30,000	40,000	3.5%	7.0%	1.8%
	Jamaica	1,000	1,500	200	300	3.9%	8.1%	0.2%
	Kazakhstan	9,000	10,000	250	350	0.3%	0.4%	0.4%
	Kyrgyzstan	4,000	4,500	600	1,000	4.2%	6.0%	0.7%
	Latvia	1,500	1,500	75	75	0.1%		0.3%
	Macedonia	1,000	1,000	20	20	0.9%	1.8%	0.5%
	Malawi	20,000	20,000	2,000	2,500	3.2%	7.4%	2.6%
	Mexico	25,000	40,000	5,000	8,250	3.1%	6.1%	0.7%
	Moldova	2,500	2,500	40	40	0.2%	0.4%	0.3%

Additional mortality – yearly average · Additional economic costs in 2010 USD (negative numbers show gains) – yearly average · Additional persons affected – yearly average


2030
CLIMATE
CARBON
Envi. Disasters
Habitat Change
Health Impact
Industry Stress
Envi. Disas.
Habitat Change
Health Impact
Industry Stress
Panama
Papua New Guinea
Paraguay
Rwanda
Sao Tome and Principe
Senegal
Seychelles
Sierra Leone
Solomon Islands
Somalia
Suriname
Timor-Leste
Togo
Tuvalu
Ukraine
Vanuatu
Vietnam
Zambia
Antigua and Barbuda
Bangladesh
Belarus
Bosnia and Herzegovina
Botswana
Brunei
Cape Verde
Colombia
Comoros
Costa Rica
Djibouti
El Salvador
Eritrea
Ethiopia
Georgia
Ghana
Grenada
Guatemala
Haiti
Indonesia
Jamaica
Kazakhstan
Kyrgyzstan
Latvia
Macedonia
Malawi
Mexico
Moldova
Acute
Severe
High
Moderate
Low

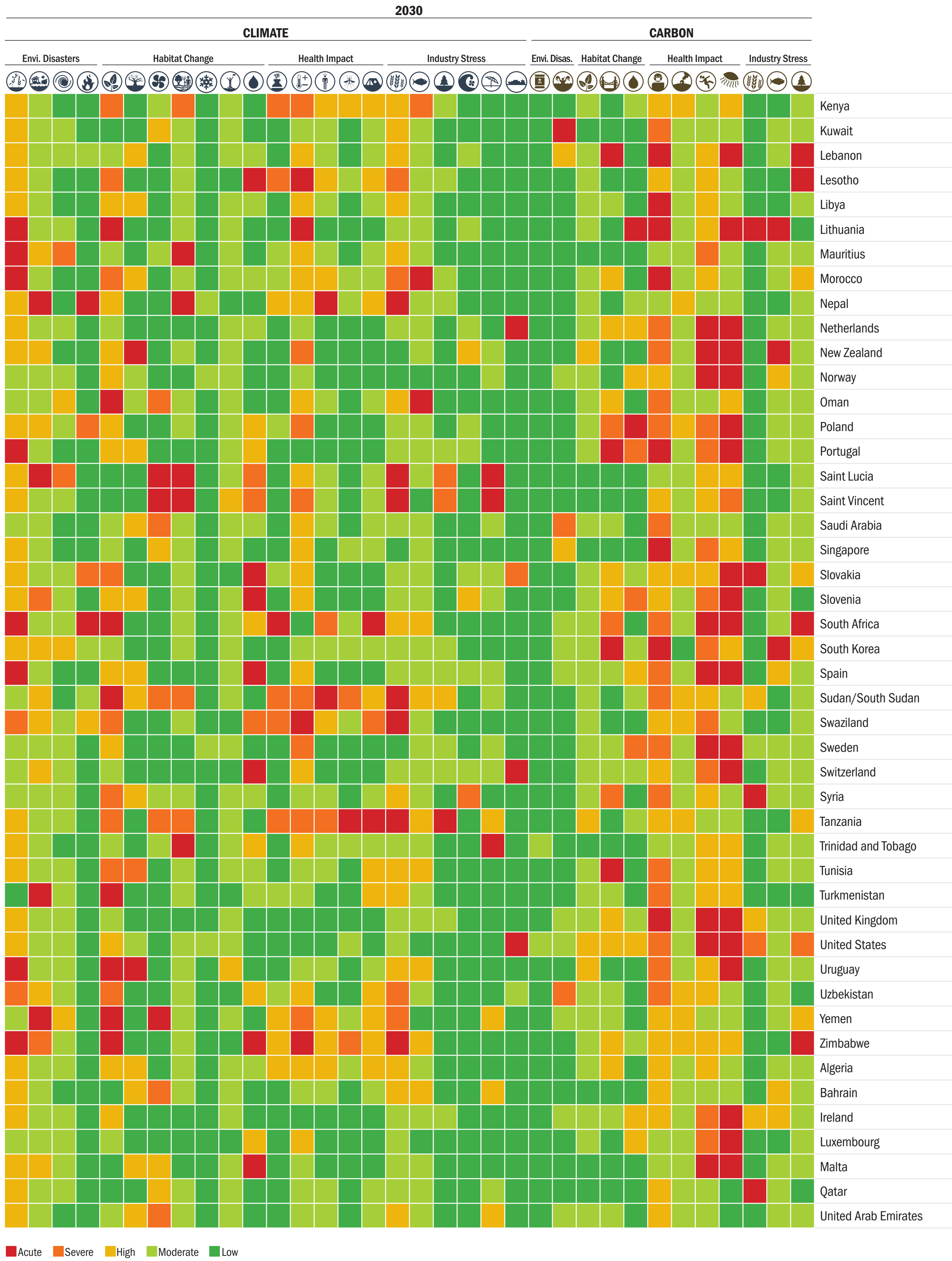
Group	Country	TOTAL 2010	TOTAL 2030	1,000s 2010	1,000s 2030	% GDP PPP 2010	% GDP PPP 2030	% GDP PPP 2010
SEVERE	Nigeria	200,000	200,000	20,000	25,000	4.0%	7.6%	2.3%
SEVERE	North Korea	9,500	10,000	3,500	4,500	7.0%	10.9%	0.2%
SEVERE	Peru	7,000	9,000	1,750	2,500	1.3%	3.0%	2.8%
SEVERE	Philippines	35,000	50,000	9,000	10,000	3.5%	7.1%	0.9%
SEVERE	Romania	15,000	15,000	300	300	0.6%	1.1%	0.4%
SEVERE	Russia	100,000	80,000	8,000	15,000	0.7%	0.8%	1.0%
SEVERE	Samoa	65	70	25	35	5.2%	9.9%	0.3%
SEVERE	Sri Lanka	8,500	9,000	1,500	2,250	3.6%	7.4%	0.6%
SEVERE	Tajikistan	6,000	7,000	450	600	1.5%	2.6%	1.0%
SEVERE	Thailand	25,000	30,000	7,500	9,000	3.6%	7.2%	0.6%
SEVERE	Tonga	35	40	75	100	5.3%	9.6%	0.2%
SEVERE	Turkey	35,000	50,000	2,500	4,000	0.6%	1.2%	0.5%
SEVERE	Uganda	30,000	35,000	4,000	5,750	2.3%	5.4%	2.4%
SEVERE	Venezuela	5,000	6,500	1,500	1,750	3.1%	6.2%	1.3%
HIGH	Albania	850	950	100	150	0.6%	1.2%	0.3%
HIGH	Argentina	15,000	15,000	1,500	2,000	1.0%	1.5%	1.6%
HIGH	Australia	4,000	6,500	2,500	2,750	0.5%	0.8%	1.1%
HIGH	Austria	1,500	2,000	45	65	0.6%	1.2%	0.2%
HIGH	Azerbaijan	4,500	4,500	250	200	0.4%	0.7%	0.4%
HIGH	Barbados	25	25	35	45	2.5%	5.2%	0.1%
HIGH	Belgium	2,000	2,500	2,250	2,500	0.1%		0.1%
HIGH	Bhutan	400	600	150	250	2.0%	3.0%	1.9%
HIGH	Brazil	55,000	70,000	10,000	15,000	0.7%	1.4%	1.9%
HIGH	Canada	4,500	6,500	1,250	2,000	0.2%	0.1%	1.4%
HIGH	Chile	4,500	6,000	650	900	1.0%	1.9%	0.8%
HIGH	Croatia	1,500	2,000	200	350	1.4%	2.8%	0.3%
HIGH	Cuba	4,500	5,000	500	600	2.7%	5.4%	0.4%
HIGH	Cyprus	350	450	40	55	0.3%	0.6%	0.1%
HIGH	Czech Republic	2,500	3,000	25	30	0.4%	0.8%	0.2%
HIGH	Denmark	1,000	1,500	1,250	1,250	-0.1%	-0.3%	0.2%
HIGH	Dominican Republic	3,000	3,500	550	950	2.4%	4.8%	0.3%
HIGH	Ecuador	2,000	2,500	850	1,250	0.5%	1.3%	1.3%
HIGH	Egypt	25,000	30,000	4,000	6,000	0.5%	1.0%	0.2%
HIGH	Estonia	250	300	15	20	0.8%	0.7%	0.6%
HIGH	Finland	900	1,000	300	300	-0.8%	-1.6%	0.6%
HIGH	France	10,000	15,000	3,500	4,500	0.5%	0.9%	0.1%
HIGH	Germany	15,000	20,000	3,250	3,750			0.1%
HIGH	Greece	4,500	5,000	500	650	0.6%	1.1%	0.2%
HIGH	Hungary	3,500	4,500	45	50	0.2%	0.4%	0.3%
HIGH	Iceland	60	80	35	35	-0.3%	-2.6%	0.1%
HIGH	Iran	25,000	50,000	2,000	3,000	0.7%	1.5%	0.3%
HIGH	Iraq	10,000	20,000	3,000	7,250	0.6%	1.3%	0.5%
HIGH	Israel	2,000	3,500	50	75	0.1%	0.1%	0.1%
HIGH	Italy	15,000	15,000	3,000	4,250	0.1%	0.3%	0.1%
HIGH	Japan	35,000	40,000	6,750	7,500	0.1%	0.1%	0.2%
HIGH	Jordan	2,000	3,000	150	200	0.1%	0.3%	0.1%

Additional mortality – yearly average; Additional economic costs in 2010 USD (negative numbers show gains) – yearly average; Additional persons affected – yearly average


2030
CLIMATE
CARBON
Envi. Disasters
Habitat Change
Health Impact
Industry Stress
Envi. Disas.
Habitat Change
Health Impact
Industry Stress
Nigeria
North Korea
Peru
Philippines
Romania
Russia
Samoa
Sri Lanka
Tajikistan
Thailand
Tonga
Turkey
Uganda
Venezuela
Albania
Argentina
Australia
Austria
Azerbaijan
Barbados
Belgium
Bhutan
Brazil
Canada
Chile
Croatia
Cuba
Cyprus
Czech Republic
Denmark
Dominican Republic
Ecuador
Egypt
Estonia
Finland
France
Germany
Greece
Hungary
Iceland
Iran
Iraq
Israel
Italy
Japan
Jordan
Acute
Severe
High
Moderate
Low

		TOTAL		1,000s		% GDP PPP		% GDP PPP
		2010	2030	2010	2030	2010	2030	2010
HIGH	Kenya	25,000	20,000	2,750	3,750	1.8%	3.7%	1.4%
	Kuwait	400	600	150	200	0.2%	0.5%	2.5%
	Lebanon	1,500	2,000	200	300	0.2%	0.5%	0.5%
	Lesotho	550	500	75	100	0.9%	1.9%	0.4%
	Libya	3,000	4,000	200	250	0.5%	1.0%	0.2%
	Lithuania	1,000	1,500	45	50	-0.1%	-0.1%	0.4%
	Mauritius	90	85	-40	-100	3.3%	6.7%	0.1%
	Morocco	10,000	15,000	2,750	4,250	1.1%	2.5%	0.1%
	Nepal	15,000	20,000	3,250	4,750	2.2%	4.1%	1.0%
	Netherlands	3,500	4,500	15,000	15,000	0.1%	-0.1%	0.1%
	New Zealand	1,000	1,500	650	800	0.4%	0.6%	1.0%
	Norway	800	1,000	300	350	-0.8%	-1.7%	0.2%
	Oman	550	1,000	55	80	0.9%	2.1%	0.1%
	Poland	15,000	15,000	350	350	0.1%	0.2%	0.3%
	Portugal	3,500	4,000	500	600	0.2%	0.4%	0.2%
	Saint Lucia	25	25	20	25	3.2%	6.6%	0.1%
	Saint Vincent	20	20	25	30	3.3%	6.3%	0.1%
	Saudi Arabia	6,000	10,000	700	900	0.2%	0.5%	0.4%
	Singapore	2,000	3,000	650	750			0.2%
	Slovakia	1,500	2,000	15	15	0.5%	1.1%	0.3%
	Slovenia	350	400	20	35	0.7%	1.5%	0.2%
	South Africa	15,000	20,000	10,000	20,000	0.9%	1.9%	0.7%
	South Korea	10,000	15,000	2,250	1,750	0.3%	0.4%	0.1%
	Spain	10,000	10,000	1,500	2,000	0.5%	1.0%	0.2%
	Sudan/South Sudan	30,000	30,000	5,250	6,750	2.6%	5.0%	0.9%
	Swaziland	550	450	150	200	0.8%	1.6%	1.0%
	Sweden	2,000	2,500	600	700	-0.7%	-1.4%	0.4%
	Switzerland	1,500	1,500	30	40	0.2%	0.3%	0.1%
	Syria	5,000	7,000	450	700	0.3%	0.7%	0.5%
	Tanzania	30,000	30,000	5,500	7,500	2.5%	4.8%	2.1%
	Trinidad and Tobago	150	150	85	100	2.2%	4.4%	
	Tunisia	2,500	3,000	950	1,250	0.9%	1.7%	0.1%
	Turkmenistan	1,500	2,000	200	200	1.1%	1.9%	0.2%
	United Kingdom	15,000	20,000	5,250	5,750	-0.1%	-0.3%	0.1%
	United States	80,000	100,000	10,000	15,000	0.3%	0.5%	0.8%
	Uruguay	1,000	1,000	250	300	1.6%	2.7%	0.7%
	Uzbekistan	15,000	20,000	650	750	0.4%	0.9%	0.7%
	Yemen	15,000	25,000	2,250	3,500	1.4%	2.8%	0.8%
	Zimbabwe	8,000	7,000	650	850	1.6%	3.3%	1.3%
MODERATE	Algeria	5,000	6,500	3,000	4,250	0.2%	0.5%	0.1%
	Bahrain	100	150	200	250	0.4%	0.8%	
	Ireland	350	550	300	300		-0.2%	0.1%
	Luxembourg	40	60	1	5	0.1%	0.2%	
	Malta	20	20	50	80	0.5%	0.9%	
	Qatar	100	150	60	90	0.1%	0.3%	0.1%
	United Arab Emirates	700	900	55	85	0.3%	0.7%	0.1%

Additional mortality – yearly average; Additional economic costs in 2010 USD (negative numbers show gains) – yearly average; Additional persons affected – yearly average


2030
CLIMATE
CARBON
Envi. Disasters
Habitat Change
Health Impact
Industry Stress
Envi. Disas.
Habitat Change
Health Impact
Industry Stress
Kenya
Kuwait
Lebanon
Lesotho
Libya
Lithuania
Mauritius
Morocco
Nepal
Netherlands
New Zealand
Norway
Oman
Poland
Portugal
Saint Lucia
Saint Vincent
Saudi Arabia
Singapore
Slovakia
Slovenia
South Africa
South Korea
Spain
Sudan/South Sudan
Swaziland
Sweden
Switzerland
Syria
Tanzania
Trinidad and Tobago
Tunisia
Turkmenistan
United Kingdom
United States
Uruguay
Uzbekistan
Yemen
Zimbabwe
Algeria
Bahrain
Ireland
Luxembourg
Malta
Qatar
United Arab Emirates
Acute
Severe
High
Moderate
Low