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Determining the Impact of Climate Change on Insurance Risk and the Global Community

Phase I: Key Climate Indicators

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Executive Summary

Since 2005, severe weather and climatological events accounted for 85% to 90% of natural hazards resulting in claims of property damage or personal injury, according to global totals (Munich Re, 2012). Prompted by evidence of recent increases in damages due to such events and longer-term climate trends, this report presents a summary of the most recent data from the area of climate change research. This effort is intended to inform both the worldwide community of actuaries, business leaders, and the general public of the weight of scientific evidence regarding the Earth's climate and the changes it is undergoing.

Scientists studying the Earth's climate system, which encompasses the entirety of the atmosphere, land surface and oceans, have developed a sophisticated understanding of how this system operates and varies over a wide range of time scales. Over the last several decades, these researchers[1] have discovered that additional changes are occurring, on both regional and global scales that exceed what is to be expected from natural climate variability alone. In the case of surface air temperature, this phenomenon has come to be known as *global warming*, but similar directional changes have been measured for many other climate variables, including ocean temperature, sea level, precipitation, sea ice extent and thickness, soil moisture, and others. The main changes that have occurred, synthesized from a large body of long-term data published in peer-reviewed scientific publications, are the following:

- *Global mean surface temperatures have risen by three-quarters of a degree Celsius (1.3 degrees Fahrenheit) over the last 100 years (1906–2005). Further, the rate of warming over the last 50 years is almost double that over the last 100 years.*
- *The 16 warmest years on record occurred in the 17-year period from 1995 to 2011.*
- *Land regions have warmed at a faster rate than the oceans, which is consistent with the known slower rate of heat absorption by seawater.*
- *Average Arctic temperatures increased at almost twice the global average rate in the past 100 years.*
- *The thickness and areal extent of Northern Hemisphere snow cover and Arctic sea ice has decreased steadily over the last 30 years, in response to this enhanced polar warming. The last decade (2002-2011) contains the 9 lowest recorded extents of annual minimum Arctic sea ice. 2012 is presently tracking at record low levels.*

[1] Anderegg et al (2010) examined a database of 1,372 climate researchers to reveal that: i) 97-98% supported the United Nations Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report finding that most of the warming observed over the latter part of the 20th century was a consequence of human activities; ii) Those researchers who disagreed with this notion had a significantly lower scientific expertise and prominence as measured by their total number of climate publications and the times these publications were cited by other researchers.

- *The area of glaciers has been decreasing worldwide since the 1960s, as has the thickness of the vast Greenland and Antarctic ice sheets over the past two decades.*

- *Global average sea level has been rising at a rate of approximately 3 mm (1/8”) per year over the past two decades. About half of this rise is due to the expanded volume of sea water under increased temperatures, and the other half to the melting of land ice.*

- *Regionally, changes in climate variables can be significantly higher or lower than the global average. To give two examples relating to sea-level rise (SLR): (1) in the Southwestern Pacific Ocean, home to numerous low-lying island communities, the rate of SLR is almost 4 times the global mean value; and (2) at two-thirds of measurement stations along the continental shores of the United States, SLR has led to a doubling in the annual risk of what were considered “once-in-a-century” or worse floods.*

- *Clear evidence has emerged that ecosystems are responding to strong regional warming, e.g., with leaf onset and fruit ripening shifting to earlier in the year and bird and insect populations shifting their ranges poleward.*

- *Over the past five decades, the frequency of abnormally warm nights has increased, and that of cold nights decreased, at most locations on land. Further, the fraction of global land area experiencing extremely hot summertime temperatures has increased approximately ten-fold over the same period.*

- *A significant increase in the frequency of heavy precipitation events has been observed in the majority of locations where data are available, and particularly in the eastern half of North America and Northern Europe, where there is a long record of observations.*

Climate experts explain the global warming phenomenon using scientific principles relating to the Earth’s thermal balance and the known history of greenhouse gas amounts in the atmosphere. This has allowed independent simulation of these characteristics using complex computer models of the climate system, driven by the known history of industrial emissions of these gases. These models successfully reproduce the observed features of historical climate change noted above. This has prompted an exploration of possible future states of the climate system, using the same models driven by various industrial emissions scenarios based on assumptions of socio-economic variables such as population, economic policies, and technological development. Broadly speaking, global climate models project a continuation of the above historical trends in climate variables, including the following:

- *A larger increase in temperature over land than over ocean, and in polar regions compared to lower latitudes.*

- *Continuing or accelerating losses of ice and snow over ocean and land.*

- *An overall strengthening of the hydrological cycle, leading to precipitation increases at mid-to-high latitudes and decreases in low latitudes.*

- *An increase in the frequency of hot extremes worldwide, and increased frequency of drought in normally dry regions and extreme rainfall/flooding in normally wet regions.*

- *A slight decrease in the frequency of tropical cyclones, but an increase in their average intensity and destructive potential.*

The implications of these wide-ranging and rapid changes in climate for human populations, their economic and societal structures, and the ecosystems on which they depend are an object of concern, and several examples of such impacts are detailed in the report. Moreover, there is a perceived need to quantify the risk posed by a changing climate to human health and capital, an area traditionally the domain of insurers and actuaries. By making use of the detailed climate observations of the past century, simplified representations of the changes in many climate variables can be formulated. These are referred to as *climate indices*. The report presents numerous examples of such indices, with the main conclusions:

- *Various indices can be constructed, using either observed data or model projections, which adequately reflect changes in the underlying climate variable(s).*

- *A composite index, carrying information from many individual climate variables and standardized with respect to climate variability, can be formulated which would suit the needs of both actuaries and the public at large. This is termed the Actuaries Climate Change Index™, or ACCI™ for short.*

- *Such an index could carry information regarding the occurrence of climate extremes, as well as more gradual changes in mean quantities.*

- *The index could be calculated on individual regions of interest, provided sufficient high-quality data are available.*

- *Finally, with the addition of socioeconomic data, the ACCI can form the basis of a more targeted index that reflects the risk to populations and capital due to climate change (the Actuaries Climate Risk Index™, or ACRI™).*