



Climate Change Vulnerability

Introduction

Climate change is arguably the largest environmental challenge facing humankind. If it continues unabated, it will very likely cause tremendous damages to infrastructure, lead to hundreds of thousands of deaths from floods, heat waves, malnutrition, vector borne diseases and trigger the extinction of many species. Climate change related risks can easily become even more disastrous if certain (as-of-yet not always identifiable) tipping points in the climate system are crossed. But even if this does not happen, changes in the climate system will have multiple and interdependent impacts on societal and ecological systems. Our understanding of these changes and their various impacts is sometimes limited. What is clear though, is that many countries around the world will be affected in one way or the other. In the report *Innovation in a Warming World*, we discuss these various impacts at length and identify technological and societal solutions, which can be engendered through R&D. As part of this larger study, we present a Climate Change Vulnerability (CCV) Monitor. The CCV Monitor assesses global variations in vulnerability to climate change on the basis of a simple country level index which gauges vulnerability to three main potential impacts of global warming:¹

- 1) Increase in weather-related disasters,
- 2) Sea level rise, and
- 3) Loss of agricultural productivity.

The selection of these three factors is based on the availability of comparable country level data as well as on the magnitude of their impacts. As such, we consider that these factors, both individually and in their combination, provide a useful representation of the overall vulnerability to climate change of a particular country. Below, we describe the three indicators and the overall Climate Change Vulnerability Index in some more detail.

Weather-related Disasters

Climate change will increase the frequency of extreme weather events such as heat waves, wildfires, and floods. These extreme weather events will likely wreak havoc on societies with high human toll. The 2003 European heat wave, for instance, is estimated to have caused more than 70,000 excess

¹ These three indicators were proposed by David Wheeler from the Center for Global Development. Wheeler, D., "Quantifying Vulnerability to Climate Change: Implications for Adaptation Assistance", Working Paper N°240, January 2011, http://www.cgdev.org/files/1424759_file_Wheeler_Quantifying_Vulnerability_FINAL.pdf.



deaths.² In assessing the vulnerability to weather-related disasters, we consider the number of people that were either killed or wounded or became homeless as a result of weather-related disasters as a percentage of the overall population over the last two decades.³

Sea Level Rise

Global warming is causing the melting of ice sheets and a corresponding increase in global sea levels. It will amplify threats from storms, coastal flooding, and erosion in coastal areas. Currently, more than 200 million people live in coastal floodplains and many major cities are vulnerable to coastal flooding. In assessing the vulnerability to sea level rise, we use the percentage of the total population living in areas where elevation is below 5 meters.⁴

Loss of Agricultural Productivity

The yield of agricultural crops will likely be improved by warmer temperatures and the carbon fertilization effect in temperate climates (mid to high altitudes). However, the effect of even small increases in temperature in tropical regions is likely to be negative and is expected to result in considerable losses of agricultural production. This can put millions of people at the risk of hunger since populations of many tropical countries are relatively poor and spend a large share of income on food. In assessing the vulnerability to the effects of global warming on agricultural production, we consider long term projections for the impact of global warming (by 2080).⁵ To account for differences in the economic importance of agriculture for countries worldwide, we scale (i.e., multiply) the estimates of changes in agricultural productivity by the agriculture value added as a percentage of GDP (for 2010 or latest available).⁶

² Robine, J.-M., Cheung, S. L. K., Le Roy, S., Van Oyen, H., Griffiths, C., Michel, J.P., and Herrmann, F. R., "Death toll exceeded 70,000 in Europe during the summer of 2003", *Comptes Rendus Biologies*, Volume 331, Issue 2, 99. 171–178, 2008.

³ Data from EM-DAT: The OFDA/CRED International Disaster Database of the Belgian Université Catholique de Louvain, as provided by the World Bank. Source: <http://www.emdat.be/database> and <http://data.worldbank.org/indicator/EN.CLC.MDAT.ZS>.

⁴ Data from the Center for International Earth Science Information Network (CIESIN), Columbia University, PLACE II dataset, as provided by the World Bank. Source: <http://data.worldbank.org/indicator/EN.POP.EL5M.ZS>.

⁵ Cline, W.R., "Chapter 5: Country-Level Agricultural Impact Estimates", in *Global Warming and Agriculture: Impact Estimates by Country*, Washington, D.C.: Center for Global Development and Peterson Institute for International Economics, 2007, <http://www.cgdev.org/doc/books/Cline%20global%20warming/Chapter%205.pdf>.

⁶ We use World Bank's World Development Indicators Database for this variable. Source: <http://data.worldbank.org/data-catalog/world-development-indicators>.



Climate Change Vulnerability Index

This aggregate vulnerability score is calculated as a simple average of three individual indicators normalized at the scale from 0 to 1.⁷ As such, it assesses the relative vulnerability of countries to the major climate change impacts rather than the absolute impacts. It goes without saying that our index presents only a simplified picture of country vulnerability omitting many of the more finely grained nuances.⁸ It is nonetheless a useful tool for a quick and simple assessment and comparison of country vulnerabilities to climate change. We invite the reader to access the results of the GeoRisQ Monitor [here](#). For further analysis, we refer to our report *Innovation in a Warming World*.

⁷ A detailed methodology for constructing the index and data sources is described in the Methodology Document.

⁸ For example, country level aggregation by necessity averages local effects of climate change that might vary significantly in the same country. Since the index includes only three indicators, it also omits many other potential impacts of climate change.