Testimony of
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Chapter 19. Assessing Key Vulnerabilities and the Risk from Climate Change

Before the
House Committee on Science and Technology Hearing,
“The State of Climate Change Science 2007: The Findings of the Fourth Assessment Report of IPCC Working Group II Report,
Climate Change Impacts, Adaptation, and Vulnerability."

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I. Background of IPCC Assessment Process.

Assessment of the description, causes and implications of climate change is made on the basis of scientific analyses of a very complex coupled human-natural system requiring knowledge from physical, biological and social sciences, as well as the technology and the development communities. This implies that there will be a great deal of uncertainty in many elements of any such an assessment. Effective assessments try to separate out from the scientific literature and various often-contradictory claims from stakeholder groups the elements of scientific analysis that are well established, from those that are best characterized by competing explanations, from those that are more speculative. Given the complexities, it is often very difficult for non-specialists to sort out this ordered set of conclusions from established to speculative and thus governments have turned to assessment bodies to help with that process. In the US, for example, the National Research Council (NRC) has produced dozens of reports on climate change science and policy options that have important influence owing to their credibility, as each is heavily peer reviewed and produced by scientists known to be field leaders. However, national reports are less credible sometimes in other countries, and thus in the late 1980s governments set up an international assessment institution parallel to the NRC that would have a broad representation of disciplines, groups and nations.

The credibility of these Intergovernmental Panel on Climate Change (IPCC) assessments has generally been very high for similar reasons to the NRC reports: front rank scientists and others are joined together as Lead Authors, three rounds of reviews are undertaken, Lead Authors must justify their response to reviewers satisfactorily to a panel of about 3 Review Editors for each chapter, and governments approve line by line the Summary for Policymakers (SPM) in a week-long Plenary at the end of the writing process—typically about 3 years. There are 3 working groups: Working Group 1 on the science of climate change and projections of its trends, Working Group 2 on the impacts of climate changes on environment and society and Working Group 3 on the policy implications. There is some overlap among topics mandated for each working group to address, and thus there are some Lead Authors in common in more than one report, as well as a Synthesis Report produced by lead authors from all working groups after the 3 more disciplinary working group reports are approved. The assessors are charged with addressing policy relevant questions—such as the pros and cons of policy alternatives as expressed in the literature—as dictated in a government document (the Plenary-Agreed Outline—PAO); but authors are asked to avoid being policy prescriptive—that is, expressing preferences on implementing any of the many options analyzed. In this testimony I will focus on the chapter I was a Coordinating Lead Author for:

<u>IPCC Working Group II Fourth Assessment Report</u>.
"Chapter 19 Assessing Key Vulnerabilities and the Risk from Climate Change."

II. Scope of Chapter 19.

The Plenary Agreed Outline (PAO) for Chapter 19 is as follows:

“19. Assessing Key Vulnerabilities and the Risk from Climate Change

- Methods and concepts: issues relating to Article 2 of the UNFCCC; reasons for concern; measuring damage; identifying key impacts and vulnerabilities, and their risk of occurrence
- Approaches to determining levels of climate change for key impacts
- Assessing key global risks
- Assessing key risks for regions and sectors
- Assessment of response strategies to avoid occurrence: stabilization scenarios; mitigation/adaptation strategies; avoiding irreversibilities; role of sustainable development; treatment of uncertainty
- Uncertainties, unknowns, priorities for research”

Therefore, our chapter addresses each of these topics by reviewing the literature and evaluating the state of the science. It is not simply a listing of the works in the literature that constitutes an assessment, but an evaluation of the confidence that the authors have in the quality of the science and its relevance for decision makers. The latter is determined by both the PAO (at the outset) and by (in the middle of the writing process) reviews from experts and governments, as these reviews help Lead Authors to sort out what materials to include from the vast array of possibilities in the literature and to establish a consensus on the confidence in the state of the science or key conclusion. Since the title of Chapter 19 includes the word “Key”, I will first explain how that PAO-required issue was addressed by the authors, drawing primarily from the text of the chapter. In the following, the square brackets with numbers in them are the sections of the semi-final draft of Chapter 19 where the detailed information on the topic can be obtained. After final consistency checking, the final chapter will be available on the IPCC Working Group II website about early May 2007.

III. Defining and Assessing What is a “Key Vulnerability.”

Climate change will lead to changes in geophysical, biological and socio-economic systems. An impact describes a specific change in a system caused by its exposure to climate change. Impacts may be judged to be harmful or beneficial. Vulnerability to climate change is the degree to which these systems are susceptible to, and unable to cope with, the adverse impacts. The concept of risk, which combines the magnitude of the impact with the probability of its occurrence, captures uncertainty in the underlying processes of climate change, exposure, impacts and adaptation. [19.1.1]

Many of these impacts, vulnerabilities and risks merit particular attention by policy-makers due to characteristics that might make them *key*. The identification of potential key vulnerabilities is intended to provide guidance to decision-makers for identifying levels and rates of climate change that may be associated with “dangerous anthropogenic interference” (DAI) with the climate system, in the terminology of United Nations Framework Convention on Climate Change (UNFCCC) Article 2. The precise language of Article 2--which the United States has signed and ratified--relevant to Chapter 19 is:

"The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

Ultimately, the definition of DAI cannot be based on scientific arguments alone, but involves other judgements informed by the state of scientific knowledge. No single metric can adequately describe the diversity of key vulnerabilities, nor determine their ranking. [19.1.1]

This chapter identifies seven criteria from the literature that may be used to identify key vulnerabilities, and then describes some potential key vulnerabilities identified using these criteria. The criteria are [19.2]:

- magnitude of impacts
- timing of impacts
- persistence and reversibility of impacts
- potential for adaptation
- distributional aspects of impacts and vulnerabilities
- likelihood (estimates of uncertainty) of impacts and vulnerabilities and confidence in those estimates
- importance of the system(s) at risk

Key vulnerabilities are associated with many climate-sensitive systems, including food supply, infrastructure, health, water resources, coastal systems, ecosystems, global biogeochemical cycles, ice sheets, and modes of oceanic and atmospheric circulation. [19.3]

In order to provide guidance to decision makers on the kinds of impacts that many in the literature could consider "key," Chapter 19 prepared a synthetic summary table of representative key impacts, risks and vulnerabilities, as was required from our Plenary Agreed Outline. After many rounds of review and exchanges with authors in other chapters in all working groups, the following table has emerged. Confidence levels from the literature, other chapters, reviewers, and the Chapter 19 authors' scientific judgments are amalgamated and appear in the table with "o" implying low confidence (about 2 in 10 chance), "*" medium confidence (about a 5 in 10 chance of occurring), "**" high confidence (about an 8 in 10 chance of occurring) and "***" very high confidence (greater than 9 in 10 chance of occurring). That convention is used throughout the Working Group II Fourth Assessment Report (AR4). Table 19.1, the result of the process just described, follows:

Table 19.1: *Examples of potential key vulnerabilities. This list is not ordered by priority or severity but by category of systems, processes, or groups either affected or which cause vulnerability. Information is presented where available on how impacts may change at larger increases in global mean temperature (GMT). All increases in GMT are relative to circa 1990. Entries are necessarily brief to limit the size of the table, so further details, caveats and supporting evidence should be sought in the accompanying text, cross-references and in the primary scientific studies referenced in this and other chapters of the AR4. In many cases climate change impacts are marginal or synergistic on top of other existing and changing stresses. Confidence symbol legend: *** very high confidence, ** high confidence, * medium confidence, • low confidence. Sources in [-] are from chapters in the Fourth Assessment. Where no source is given, the entry represents conclusions of Chapter 19 authors.*

Systems, Processes, or Groups at Risk[Cross-references]	**Prime criteria for "key vulnerability" (from 7 criteria; 19.2) Short, descriptive words.**	**Relationship between temperature and risks (source to text) Temperature change by 2100 (above 1990-2000 levels)**					
		0°C	**1°C**	**2°C**	**3°C**	**4°C**	**5°C**
Global Social Systems							
Food Supply [19.3.2.2]	Distribution, Magnitude	Crop yield potential starts to dec at low latitudes* [5.2] Crop yield potential starts to inc at mid/high latitude* Global production potential likely to increase* [5.6]		Global production potential increases to around 3°C, * [5.6]		Yields of grain crops decline at mid/high lats * [5.2] Global production potential very likely to decrease above about 3 deg C* [5.6]	
Infrastructure [19.3.2]	Distribution, Magnitude, Timing	Damages likely to increase exponentially, sensitive to rate of climate change, change in extreme events, and adaptive capacity ** [3.5, 6.5.3, 7.5].					
Health [19.3.2]	Distribution, Magnitude, Timing, Irreversibility	Current effects are small but discernible * [1.3.7;8.4.1]	Although some risks would be reduced, aggregate health impacts would increase, particularly from malnutrition, diarrhoeal diseases, infectious diseases, floods and droughts, extreme heat, and other sources of risk */**. Sensitive to status of public health system ***. [8.ES, 8.3, 8.4, 8.6]				
Water Resources [19.3.2]	Distribution, Magnitude, Timing	Dec water availability and inc drought in some mid-lats and aemi-arid low lats ** [3.4, 3.7]	Severity of floods, droughts, erosion, water-quality deterioration will increase with increasing climate change ***. Sea level rise will extend areas of salinisation of groundwater, decreasing freshwater availability in coastal areas ***. [Ch 3 ES]. Hundreds of millions people would face reduced water supplies ** [3.4.3].				

Migration and Conflict	Distribution, Magnitude	Stresses such as increased drought, water shortages, and riverine and coastal flooding will affect many local and regional populations **. This will lead in some cases to relocation within or between countries, exacerbating conflicts and imposing migration pressures *. [19.2]

Aggregate Market Impacts and Distribution	Magnitude, Distribution	Uncertain net benefits and greater likelihood of lower benefits or higher damages than in TAR o. Net market benefits in many high latitude areas; net market losses in many low latitude areas. * [20.6] Most people negatively affected o/*.	Net global negative market impacts increasing with higher temperatures * [20.6]. Most people negatively affected *.
Regional Systems			
Africa [19.3.3]	Distribution, Magnitude, Timing, Low Adaptive Capacity	Tens of millions of people at risk of increased water stress; increase spread of malaria*; [9.4.1, 9.4.4, 9.4.5]	Hundreds of millions of additional people at risk of increased water stress; increased risk of malaria in highlands; reductions in crop yields in many countries, harm to many ecosystems such as succulent Karoo * [9.4.1, 9.4.4, 9.4.5]
Asia [19.3.3]	Distribution, Magnitude, Timing, Low Adaptive Capacity	Over the temperature range, about 1 billion people would face risks from reduced agricultural production potential, reduced water supplies, or increases in extremes events * [14.4, 10]	
Latin America [19.3.3]	Magnitude, Irreversibility, Distribution, and Timing, Low Adaptive Capacity	Tens of millions of people at risk of water shortages •; [[13.ES, 13.4.3] many endemic species at risk from land use and climate change** (~1ºC). [13.4.1, 13.4.2]	More than a hundred million of people at risk of water shortages ~~o~~ * [13.ES, 13.4.3]; low lying coastal areas, many of which are heavily populated, at risk from sea level rise and more intense coastal storms * (about 2-3ºC) [13.4.4]. Widespread loss of biodiversity, particularly in the Amazon *. [13.2, 13.4.1, 13.4.2].

Polar Regions [19.3.3]	Timing, Magnitude, Irreversibility, Distribution, Low Adaptive Capacity	Climate change is already having substantial impacts on societal and ecological systems **. [15.ES,]	Continued warming likely to lead to further loss of ice cover and permafrost ** [15.3]. Arctic ecosystems further threatened **, although net ecosystem productivity estimated to increase ** [15.2.2, 15.4.2]. While some economic opportunities will open up (*e.g.*, shipping), traditional ways of life will be disrupted ** [15.4].
Small Island States [19.3.3]	Irreversibility, Magnitude, Distribution, Low Adaptive Capacity	Many islands already experiencing some negative effects **. [16.2]	Coastal inundation and damage to infrastructure due to sea level rise** [16.4]
Indigenous, poor or isolated communities [19.3.3]	Irreversibility, Distribution, Timing, Low Adaptive Capacity.	Many of these communities are already stressed. ** [11.4; 14.2.3; 15.4.6]	Climate change and sea level rise adds to other stresses **. Communities in low-lying coastal and arid areas are especially threatened ** [6.4;3.4]
Drying in Mediterranean, western North America, southern Africa southern Australia, and north-eastern Brazil [19.3.3]	Distribution, Magnitude, Timing	Climate models generally project decreased precipitation in these regions [3.4.2, 3.5.1; 11.3.1]. Reduced runoff will exacerbate tight water supplies, decrease water quality, harm ecosystems, and result in decreased crop yields **. [3.4.2; 11.3.2]	
Inter tropical mountain glaciers; and impacts on high-mountain communities [19.3.3]	Magnitude, Timing, Persistence, Low Adaptive Capacity, Distribution,	Inter-tropical glaciers are melting and causing flooding in some areas, shifts in ecosystems are likely to cause water security problems due to decreased storage. [9.4.5, 10.4.4, 13.2.4, 19.3]	Accelerate reduction of inter-tropical mountain glaciers. Some of these systems will disappear in the next few decades *. [10.4.2, 13.ES, 13.2.4.1]
Global Biological Systems			

Terrestrial ecosystems and biodiversity [19.3.4]	Irreversibility, magnitude, low adaptive capacity, persistence, rate of change, confidence.	Many ecosystems already affected *** [1.3] / c. 20-30% species at inc. high risk of commitment to extinction* [4.4] / Major extinctions around the globe** [4.4] [>4oC] Terrestrial biosphere tends towards a net carbon source*[4.4]
Marine ecosystems and biodiversity [19.3.4]	Irreversibility, magnitude, low adaptive capacity, persistence, rate of change, confidence.	Increased coral bleaching** [4.4] / Most coral reefs bleached**[4.4] / Widespread coral mortality**[4.4]
Freshwater ecosystems [19.3.2.2]	Irreversibility Magnitude, persistence low adaptive capacity.	Some lakes already showing decreased fisheries output; pole-ward migration of aquatic species **. [1.3.4, 4.4.9] / Intensified hydrological cycles, more severe droughts and floods ***. [3.4.3] / Extinction of many freshwater species**, major changes in limnology of lakes**, increased salinity of inland lakes**.
Geophysical Systems		
Biogeochemical Cycles [WGII 4.4.9, 19.3.5.1; WGI 7.3.3.2.2, 7.3.3.2.3, 7.3.5, 7.4.1.2, 10.4.1, 10.4.2]	Magnitude, persistence, confidence, low adaptive capacity, rate of change.	Ocean acidification already occurring and increases as CO_2 concentration increases ***; ecological changes potentially severe * [1.3.4, 4.4.9]. Carbon cycle feedback increases projected CO_2 concentrations by 2100 by 20-220ppm for SRES A2, with associated additional warming of 0.1-1.5°C **. AR4 temperature range (1.0-6.3°C) accounts for this feedback from all scenarios and models but additional CO_2 and CH_4 releases possible from permafrost, peat lands, wetlands, and large stores of marine hydrates at high latitudes. [4.4.6, 15.4.2] * Permafrost already melting, and above feedbacks generally increase with climate change, but eustatic sea level rise likely to increase stability of clathrates. [1.3.1] ***
Greenland ice sheet [WGII 6.3, 19.3.5.2; WGI 4.7.4, 6.4.3.3, 10.7.4.3, 10.7.4.4]	Magnitude, irreversibility, low adaptive capacity, confidence	Localized Deglaciation; (already observed, due to local warming); extent would increase with temperature *** [19.3.5] / Commitment to partial to near-total deglaciation *, 2-7[1] m sea level rise over centuries to millennia. [19.3.5] / Commitment to Near total deglaciation over centuries to millennia **[19.3.5]

[1] Range is based on a variety of methods including models and analysis of palaeo data [19.3.5.2]

West Antarctic ice sheet [WGII 6.3, 19.3.5.2; WGI 4.7.4, 6.4.3.3, 10.7.4.3, 10.7.4.4]	Magnitude, irreversibility, low adaptive capacity	Localized ice shelf loss and grounding line retreat *. (already observed, due to local warming) [1.3.1, 19.3.5]	Commitment to partial deglaciation, 1.5-5 m sea level rise over centuries to millennia. [19.3.5] */ o Likelihood of near-total deglaciation increases with increases in temperature [19.3.5, 12.6] **
Meridional Overturning Circulation [WGII 19.3.5.3; WGI 8.7.2.1, 10.3.4]	Magnitude, persistence, distribution, timing, low adaptive capacity, confidence	Variations including regional weakening, (already observed but no trend identified)	Considerable Weakening **. Commitment to large-scale and persistent change including possible cooling in northern high latitude areas near Greenland and NW Europe o, highly dependent on rate of climate change. [19.3.5, 12.6]
Extreme Events			
Tropical Cyclone Intensity [WGI Table TS-4, observed 3.8.3, Q3.3, 9.5.3.6, projected Q10.1] [WGII 6.5.2, 7.5, 8.7, 11.4.5, 16.2.2, 19.3.6]	Magnitude, Timing, Distribution	Increase in Cat. 4-5 storms*/**, with impacts exacerbated by sea level rise	Further increase in tropical cyclone intensity */** exceeding infrastructure design criteria with large economic costs ** and many lives threatened **.
Flooding, both large–scale and flash floods [WGI, Table TS-4, 10.3.6.1, Q10.1, 14.4.1]	Timing, Magnitude	Increases in flash flooding in many regions due to increased rainfall intensity** and in floods in large basins in mid and high latitudes **.	Increased flooding in many regions (e.g., North America and Europe) due to greater increase in winter rainfall exacerbated by loss of winter snow storage **. Greater risk of dam burst in glacial mountain lakes **. [10.2.4.2]
Extreme Heat [WGI, Table TS-4, 10.3.6.2, Q10.1, 14.4.5]	Timing, Magnitude	Increased heat stress and heat waves, especially in continental areas ***.	Frequency of heat waves (according to current classification) will increase rapidly, causing increased mortality, crop failures, forest die-back and fire, and damage to ecosystems ***.
Drought [WGI Table TS-4, 10.3.6.1]	Magnitude, Timing	Drought already increasing * [1.3.3.2]. Increasing frequency and intensity of drought in mid-latitude continental areas projected ** [WGI 10.3.6.1].	Extreme drought increasing from 1% land area to 30% (A2 scenario) [WGI 10.3.6.1]. Mid-latitude regions affected by poleward migration of Annular Modes [WGI 10.3.5.5] seriously affected**.
Fire [WGI 7.3, WGII, 1.3.6]	Timing, Magnitude	Increased fire frequency and intensity in many areas, particularly where drought increases ** [4.2.1; 14.2.2].	Frequency and intensity likely to be greater, especially in boreal forests and dry peat lands after melting of permafrost ** [4.4.5; 11.3; 13.4.1, 14.4.2].

The table explicitly lists criteria used by the Lead Authors to select candidates for possible key vulnerabilities, as guidance to policy makers on the process used. Chapter 19 authors do not advise which vulnerabilities or impacts are "more important", as that requires a value judgment and would be policy prescriptive. However, explicitly showing the criteria in each case for our selection of potential key vulnerabilities is intended to be helpful to stakeholders and policy makers in their own evaluations of what they may consider "key." The Executive Summary of Chapter 19 summarizes the conclusions from Table 19.1 as follows:

General conclusions include [19.3]:

• Some observed key impacts have been at least partly attributed to anthropogenic climate change. Among these are increases in human mortality, loss of glaciers, and increases in the frequency and/or intensity of extreme events.

• Global mean temperature changes of up to 2ºC above 1990-2000 levels would exacerbate current key impacts, such as those listed above (**), and trigger others, such as reduced food security in many low-latitude nations (*). At the same time, some systems such as global agricultural productivity, could benefit (o/*).

• Global mean temperature changes of 2 to 4 C above 1990-2000 levels would result in an increasing number of key impacts at all scales (**), such as widespread loss of biodiversity, decreasing global agricultural productivity and commitment to widespread deglaciation of Greenland (**) and West Antarctic (*) ice sheets.

• Global mean temperature changes greater than 4ºC above 1990-2000 levels would lead to major increases in vulnerability (***), exceeding the adaptive capacity of many systems (***).

• Regions that are already at high risk from observed climate variability and climate change are more likely to be adversely affected in the near future due to projected changes in climate and increases in the magnitude and/or frequency of already-damaging extreme events.

IV. Reasons for Concern.

The "reasons for concern" identified in the TAR remain a viable framework to consider key vulnerabilities. Recent research has updated some of the findings from the TAR [19.3.7]:

• There is new and stronger evidence of observed impacts of climate change on unique and vulnerable systems (such as polar and high-mountain communities and ecosystems), with increasing levels of adverse impacts as temperatures increase (***).

• There is new evidence that observed climate change has likely already increased the risk of certain extreme events such as heat waves, and it is more likely than not that warming has contributed to intensification of some tropical cyclones with increasing levels of adverse impacts as temperatures increase (***).

• Distribution of impacts and vulnerabilities are still considered to be uneven, and low-latitude less-developed areas are generally at greatest risk due to both higher sensitivity and lower adaptive capacity, but there is new evidence that vulnerability to climate change is also highly variable within countries, including developed countries.

• There is some evidence that initial net market benefits from climate change will peak at a lower magnitude and sooner than was assumed for the TAR, and is likely that there will be higher damages for larger magnitudes of global mean temperature increases than estimated in the TAR.

• The literature offers more specific guidance on possible thresholds for initiating partial or near-complete deglaciation of Greenland and West Antarctica. There is less confidence since the TAR in assessments of the risk of abrupt, large scale changes to the Meridional Overturning Circulation (MOC).

V. The Potential Role of Adaptation.

Adaptation can significantly reduce many potentially dangerous impacts of climate change and reduce the risk of many key vulnerabilities. However, the technical, financial, and institutional capacity and the actual planning and implementation of effective adaptations is currently quite limited in many regions. In addition, the risk-reducing potential of planned adaptation is either very limited or very costly for some key vulnerabilities, such as loss of biodiversity, melting of mountain glaciers or disintegration of major ice sheets. [19.4.1]

A general conclusion on the basis of the present understanding is that for market and social systems there is considerable adaptation potential, but the economic costs are potentially large, largely unknown and unequally distributed, as is the adaptation potential itself. For biological and geophysical systems the adaptation potential is much less than in social and market systems. There is wide agreement that it will be much more difficult for both human and natural systems to adapt to larger magnitudes of global mean temperature change than to smaller ones, and that adaptation will be more difficult and/or costly for faster warming rates than slower rates. [19.4.1]

VI. Potential Robust Conclusions.

Several conclusions appear robust across a diverse set of studies, in the integrated assessment and mitigation literature [19.4.2; 19.4.3]:

• Given the uncertainties in factors such as climate sensitivity, regional climate change, vulnerability to climate change, adaptive capacity and the likelihood of bringing such capacity to bear, a risk management framework emerges as a useful framework to address key vulnerabilities. However, the assignment of probabilities to specific key impacts is often very difficult due to the large uncertainties involved.

• Actions to mitigate climate change and reduce greenhouse gas emissions will reduce the risk associated with most key vulnerabilities. Postponement of such actions, in contrast, generally increases risks.

• Given the current atmospheric greenhouse gas concentrations (WG I SPM) and the range of projections for future climate change, some key impacts (e.g., loss of species, partial deglaciation of major ice sheets), cannot be avoided with high confidence. The probability of initiating some large-scale events is very likely to continue to increase as long as greenhouse gas concentrations and temperature continue to increase.

Stephen Schneider Biography:

Dr. Stephen H. Schneider is the Melvin and Joan Lane Professor for Interdisciplinary Environmental Studies, Professor of Biological Sciences, and Professor (by courtesy) of Civil and Environmental Engineering. He is Co-Director of the Center for Environmental Science and Policy in the Freeman Spogli Institute for International Studies and a Senior Fellow in the Woods Institute for the Environment at Stanford University. Dr. Schneider received his Ph.D. in Mechanical Engineering and Plasma Physics from Columbia University in 1971. He studied the role of greenhouse gases and suspended particulate material on climate as a postdoctoral fellow at NASA's Goddard Institute for Space Studies. He was awarded a postdoctoral fellowship at the National Center for Atmospheric Research in 1972 and was a member of the scientific staff of NCAR from 1973-1996, where he co-founded the Climate Project.

Dr. Schneider focuses on climate change science, integrated assessment of ecological and economic impacts of human-induced climate change, and identifying viable climate policies and technological solutions. He has consulted with federal agencies and/or White House staff in the Nixon, Carter, Reagan, Clinton, and two Bush administrations.

Actively involved with the IPCC (Intergovernmental Panel on Climate Change), an initiative of the United Nations Environment Program and the World Meteorological Organization since its origin in 1988, he is currently a Coordinating Lead Author of Working Group II Chapter 19, "Assessing Key Vulnerabilities and the Risk from Climate Change," as well as contributing to the Synthesis Report, which synthesizes the contributions of Working Groups I, II, and III, for the Fourth Assessment Report (AR4) to be published in 2007. AR4 will be used by governments world-wide as the definitive document regarding climate change science, impacts, adaptation, vulnerability, and mitigation until 2012.

In 1991, Dr. Schneider was awarded the American Association for the Advancement of Science/ Westinghouse Award for Public Understanding of Science and Technology for furthering public understanding of environmental science and its implications for public policy. In 1992, he was honored with a MacArthur Fellowship for his ability to integrate and interpret the results of global climate research through public lectures, classroom teaching, environmental assessment committees, media appearances, Congressional testimony and research collaboration with colleagues. Dr. Schneider was elected to membership in the US National Academy of Sciences in April 2002. He received the Edward T. Law Roe Award of the Society of Conservation Biology in 2003. He and his spouse-collaborator, Terry Root, jointly received the National Conservation Achievement Award from the National Wildlife Federation in 2003 and the Banksia Foundation’s International Environmental Award in 2006 in Australia.

Dr. Schneider is founder and Editor of the interdisciplinary journal, *Climate Change*. Editor-in-Chief of the *Encyclopedia of Climate and Weather* and author of *The Genesis Strategy: Climate and Global Survival; Global Warming: Are We Entering the Greenhouse Century?* and *Laboratory Earth: The Planetary Gamble We can’t Afford to Lose*. In addition, he has authored or co-authored over 300 scientific papers, proceedings, legislative testimonies, edited books and book chapters, and some 115 book reviews, editorials and popularizations.

Dr. Schneider teaches undergraduate and graduate courses in Earth Systems, Human Biology, Civil Engineering, Biological Sciences, the Senior Honors Seminar in Environmental Science, Technology and Policy, and the Interdisciplinary Graduate Program in Environment and Resources, as well as guides the work of Ph.D. candidates, post-doctoral scholars, and other researchers. Currently, Dr. Schneider is counseling policy makers about the importance of using risk management strategies in climate-policy decision making, given the uncertainties in future projections of global climate change. In addition to continuing to serve as an advisor to decision-makers, he consults with corporate executives and other stakeholders in industry and the nonprofit sectors regarding possible climate-related events and is actively engaged in improving public understanding of science and the environment through extensive media communication and public outreach.