WRITTEN TESTIMONY OF
DR. JONATHAN OVERPECK
DIRECTOR, THE INSTITUTE FOR THE STUDY OF PLANET EARTH
PROFESSOR OF GEOSCIENCES
PROFESSOR OF ATMOSPHERIC SCIENCES
THE UNIVERSITY OF ARIZONA

HEARING ON WATER SUPPLY CHALLENGES FOR THE 21ST CENTURY

BEFORE THE
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRSENTATIVES

MAY 14, 2008

Chairman Lampson, Ranking Member Inglis, and other members of the Committee, thank you for the opportunity to speak with you today on water supply challenges for the twenty-first century.

My name is Jonathan Overpeck. I am the Director of the Institute for the Study of Planet Earth at The University of Arizona, where I am also a Professor of Geosciences and a Professor of Atmospheric Sciences. I have published more than 120 papers in climate and the environmental sciences, and recently served as a Coordinating Lead Author for the UN Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment (2007). I have been awarded the US Department of Commerce Bronze and Gold Medals, the Walter Orr Roberts award of the American Meteorological Society and a Guggenheim Fellowship for my interdisciplinary research. I also serve as Principal Investigator of the Climate Assessment for the Southwest (CLIMAS), an interdisciplinary Regional Integrated Science and Assessment (RISA) project funded by NOAA. In this capacity, and others, I work not only on climate system research, but also on supporting use of this research by decision-makers in society.

One of the chief potential challenges to ensuring a reliable water supply will be climate variability and climate change. I would like to describe these challenges, and then discuss what our nation can do to meet them. A basic message is that it appears likely that both climate variability and climate change are already starting to challenge water supplies in our nation, and that these on-going challenges are an important lesson for the future.

Climate Variability, Drought and Water Supply

As Figure 1 shows, drought is currently affecting significant portions of our nation. Droughts in the West, Central Plains, Texas, and in the Southeast vie for the title of worst current drought. Most notably, the drought in the West, although recently softened by good winter snowfall, has persisted since about 1999, and could be far from over.

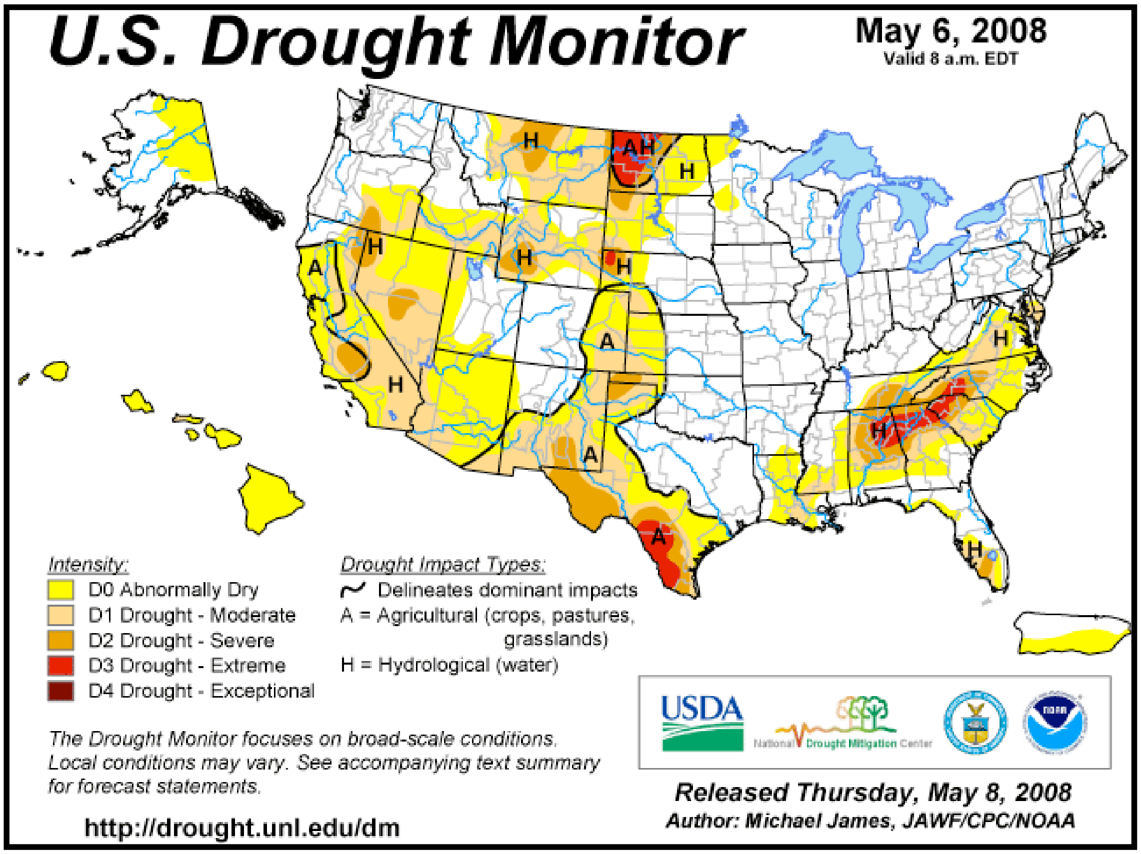

Figure 1. *Recent status of drought across the United States as of the first week of May, 2008. This map reflects recent drought relief in some areas do to above average winter snowfall in the West. The West has seen much more serious drought off and on since 1999, making the on-going western drought the worst that has occurred in the region since the nineteenth century.(From http://drought.unl.edu/dm)*

The causes of the current droughts across the U.S. are hotly debated in the climate science community, but it is safe to say that at least some of the current drought conditions are due to natural climate variability. Most likely, variability in the oceans is causing atmospheric circulation to drive drier-than-normal conditions in parts of our nation. For example, this seems to be the prime candidate for explaining the Southeast U.S. drought.

Drought of the type now occurring in the U.S. is modest compared to the more severe natural droughts that took place before the twentieth century. These earlier droughts can be reconstructed using tree-rings, lake sediments, cave formations, and other natural archives of past climate. For example, western North America, from deep into Mexico, through the western U.S. and into Canada, was gripped by a severe 20 to 25-year drought in the late sixteenth century. Droughts lasting many decades occurred during medieval times in the West, and likely had profound impacts. For example, we now know from hydrological modeling that these past “megadroughts,” were they to occur in the future, would have dramatic negative impacts on the Colorado River and the water this river supplies to seven states.

It is safe to say that the water supply infrastructure in many parts of our country (e.g., the West) would be overwhelmed were a megadrought like those of the past to occur again in the future. I will return to this challenge later in my testimony.

What is most disturbing about the natural droughts of the past is that we are not sure what caused them, nor are we confident that we can predict them. Thus, it is difficult for climate scientists to say how long the current droughts will last, or whether they will intensify. What climate scientists can say, however, is that it would be foolish to assume that droughts much longer - and more severe - than those of the last 100 years won't happen again. It is just a matter of time, and this means that we should think seriously about making our society, particularly in those areas that are prone to drought (e.g., see Figure 1), more resilient in the face of future drought.

Climate Change and Water Supply

The climate system is changing, very likely due to humans, and this change could also pose another major challenge to water supply in parts of our nation. Although temperatures over most of our country have risen over the last 100 years, climate change is most notable in the U.S. West and Alaska. Across the West, temperatures have gone up by about 2°F, and more than the national average. This warming has led to significant decreases in spring snowpack, which in turn, have led to decreased flow in some major rivers, including the Colorado River. These temperature, snow, and river flow changes appear to be due, at least in part, to human-caused climate change. These changes are also quite similar to those projected by climate models for the future.

Furthermore, there are some indications - still hotly debated in the climate science community - that the current western drought itself may be related to human causes. In the Southwest, we have seen a northward shift in winter/spring storm systems that seems consistent with our understanding of human-caused climate change, and leaves the region with below-average precipitation. However, it is too early to know for sure if the current western drought, the worst in at least 100 years, is due to humans or not. What we do know is that human-caused warming is making the impacts of the drought more serious than the cooler droughts of the twentieth century.

Many of the climate changes we are currently seeing appear to be consistent with what climate models project for the future. Given the recent (since 2000) jump in global carbon dioxide emissions to the atmosphere, we are now on track, over the next 100 years, to warm parts of the coterminous U.S. by more than 15°F in summer. This change, when coupled with dramatic warming in other seasons as well, should drive a much greater atmospheric demand for moisture, reduced spring snowpack, and regional river flows in the western U.S.

Figure 2 shows only one recent estimate of how runoff, and hence river flow, could change in the next 50 years. Other estimates exist, but for the Colorado River Basin, almost all estimates are negative; some estimate suggest as much as a 40% reduction could occur by mid-century. Future warming and precipitation change, particularly in the spring season, appears to point only to one direction of water supply change – down.

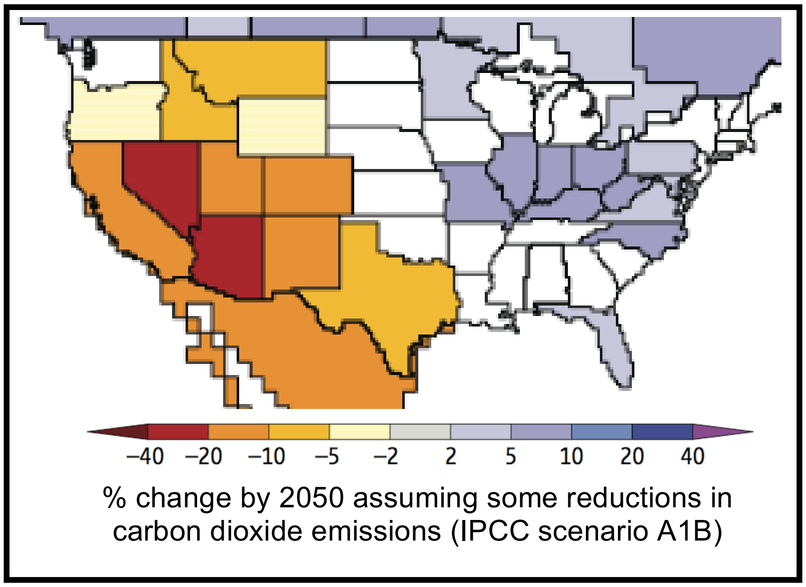

Figure 2. *Changes in runoff volume projected by the middle of the twenty-first century (relative to the period 1900 to 1970 average). Color denotes percentage change (median value from 12 climate models). Where a state is colored, 8 or more of 12 models agree on the direction (increase versus decrease of runoff change under the IPCC's "SRES A1B" emission scenario. Current emissions are significantly higher than this emission scenaro. (From Milly et al., 2008, Science 319, 573-574.).*

Might Climate Change Spare Water Supply in all but the West and Southwest?

Figure 2, as well as most other projections of future climate-related water supply, paints a challenging picture for the West and Southwest regions of the country that have recently been experiencing some of the fastest growing populations in the nation. Does this mean the rest of the country is safe from climate-related reductions in water supply? The answer is almost certainly "No".

In addition to the average change depicted in Figure 2, climate theory and projections also point to a human-caused increase in the frequency of drought. The recent IPCC (2007) assessment of climate model projections indicates much of the conterminous U.S. should see an increase in the annual maximum number of consecutive dry days between rainfall events, a decrease in average soil moisture, and an increased likelihood of drought. Although these projected changes are less certain outside the West and Southwest, the current state of climate science suggests they should be considered real possibilities for the future.

The Combined Challenge of Climate Variability and Climate Change.

Current scientific understanding of both climate variability (drought) and climate change indicates that there is a real future likelihood of both natural and human-caused reductions in climate-related water supply. We now know that decades-long droughts can occur naturally in parts of the U.S., just as climate change could lead to greater aridity and an enhanced probability of drought in many parts of the country, particularly the West, Southwest, Texas, and across to the Southeast. These are the same parts of the country that are now experiencing drought. Thus, the present could be a window on the future.

Meeting the Climate Challenge to U.S. Water Supply.

The future climate challenge confronting our nation's water supply is real, and will likely be due to both natural and human-caused threats. Fortunately, there are some "no-regrets" actions that can be taken regardless of cause:

(1) call for, and support, an accelerated effort to *understand climate-related water supply vulnerabilities*, both physical, biological, and social. Much remains to be learned about our nation's water supply, and how it might be managed in the future. It is outside the scope of this testimony to go into great detail, but some key questions warrant greater understanding:

- how can we improve the current generation of *hydrologic models* used to project future river flow? For example, model-based estimates of future climate-change related reductions in Colorado River flow range from small (e.g., 10%) to large (e.g., 40%) by the middle of the century. Effective management of future water supply will require better hydrologic models.

- how best incorporate realistic assessments of future climate change into *river management models*? This process has begun, but needs to be accelerated given the importance of realistic projections not just of physical water supply, but also how well these supplies can be managed to meet projected use.

- how much *groundwater* exists locally around the country, and how quickly can groundwater be recharged in the future, both by precipitation, and/or human mechanisms? Many parts of the country, particularly in the West, consider groundwater to be a principal source of water, at least in times of surface-flow shortage. And yet, precise information about the volume of these underground water resources is often not available, nor is the full potential of underground water banking fully understood. This limits realistic planning.

- how much water can be diverted safely from *agricultural use* to uses that support population growth in potentially water limited regions? In many areas, agriculture accounts for 70% or more of total water usage. How much of this water should be diverted from agricultural use in order to support population growth, or is water left in agriculture best viewed as a resource that can buffer long droughts when other water resources become inadequate. Water left in agriculture can be sold to non-agricultural users in order to make up for water lost to drought. What is the true value of agricultural water use?

(2) **call for, and support, an accelerated effort to *understand climate variability and climate change processes*, as well as how to predict them.** Climate change science has made tremendous advances in the last decade, but is still limited due to incomplete science infrastructure and knowledge. Essential progress can be accelerated via greater funding of basic (e.g., NSF) and "use-inspired" (e.g., NOAA, DOE and NASA) climate change research. Well-planned global climate observing systems – both *in situ* and space-based - must be completed, and special efforts are needed to extend these observing networks to include much denser climate-related observations at the local to regional scales so important for decision-making. Climate modeling capability must also be enhanced to improve the realism of state-of-the-art models, particularly with regard to simulating (and predicting) climate variability and change at the global to regional-scales needed for enhanced planning and decision-making.

Some regions with likely greater-than-average exposure to climate-related water challenges, require an extra effort to understand what is at stake and what we can do about it. For example, the Southwest U.S. is the fastest growing part of the country, but it is also the region that could be most at risk to water supply shortage. Despite this, we lack an adequate understanding of the summer monsoon system that brings substantial rainfall to some parts of the region. We can't say whether this summer rainfall will likely go up, or go down. We don't know the implications of how changes in this basic water resource could be managed. As with other key regional issues, urgent attention is needed to make sure that some parts of the country don't become big losers in the face of climate variability and change.

(3) call for, and support, a national climate service that is designed to *support local and regional decision-makers* in dealing with climate-related reductions in water supply. At present, the climate-related decision-support needs of regional stakeholders (e.g., water managers) are not met adequately. A number of federal and state agencies have recognized this problem, and planning has begun at a number of levels for a more organized, interagency, national climate service. The key to success for such a service is that it be accountable to, and meet the needs of, regional decision-makers. This service should benefit from the national climate research, observations and modeling infrastructure (e.g., within NOAA), and it should also benefit from the experiences, and stakeholder-partnerships, of the NOAA-funded interdisciplinary Regional Integrated Science and Assessment (RISA) program. Any national climate service needs to have a strong accountability mechanism to ensure that the regional decision-making needs are met, first and foremost.

In addition to the above "no-regrets" options, there is the option of mitigating – or reducing – the likely impacts of climate change on U.S. water supply:

(4) create policy that reduces *global greenhouse gas emissions.* Current state-of-the-art climate science indicates that a tighter water supply could occur in many parts of our nation due to climate change. Large temperature increases, greater atmospheric demand for moisture, increasing snow reductions, river flow declines, and a likely increase in the probability of drought, all appear to be already underway in some parts of the globe, including the U.S. Climate model projections indicate that these trends will likely create an increasing challenge to water supply into the future, to 2100 and beyond. A national climate service (see #3 above) would serve to quantify the levels of climate-related water reductions that can be met through technology, planning and adaptation. Beyond any "adaptable" level of climate change-related water supply reduction, however, exists potentially dangerous levels of climate change that can be avoided through an aggressive effort to reduce greenhouse gas emissions.

Summary

The outlook for climate-related changes in U.S. water supply is not positive, particularly in the West, Southwest, Texas and into the Southeast. Even in other parts of the nation, water supply could become more limiting. However, the good news is that there is time to prepare for increasing water supply challenge, and to also avoid water supply reduction threats deemed dangerous. Urgent attention is warranted.

Thank you for the opportunity to address you today.