

## Climate Change, Water and Uncertainty

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There are aspects of climate change about which we are almost certain (e.g. the radiative forcing of greenhouse gases) and areas in which uncertainty is rife (e.g. the effect of clouds and the response of the ocean). This paper focuses on uncertainty in climate change vis-à-vis water. We are virtually certain that the sea level shall continue to rise. Flood magnitude and frequency are likely to increase in most regions. It is very likely that precipitation will increase at high latitudes and in some wet tropics and decrease over much of the mid-latitudes and dry tropics. It is likely that drought-affected areas will increase. It is more likely than not that the increases in the frequency of heavy precipitation events, intense tropical cyclone activity and the area affected by drought include an anthropogenic contribution. With respect to water supply, it is very likely that the costs of climate change will outweigh the benefits globally. Current water management practices are very likely to be inadequate to reduce the negative impacts of climate change on water-supply reliability, flood risk, health, energy and aquatic ecosystems. Even with optimal water management, it is very likely that negative impacts on sustainable development cannot be avoided.

**Keywords:** climate change, drought, flooding, precipitation, sea level, uncertainty

### Introduction

*Uncertainty* is best described using a probability distribution, and the broader the distribution, the greater the uncertainty. Uncertainty is rife in the science associated with climate change, such as the effect of clouds, the ability of the ocean to absorb CO<sub>2</sub>, the response of biological processes to changes in both CO<sub>2</sub> concentrations and the climate, and climate change mitigation, yet there are aspects of climate science about which we are almost certain, such as the radiative forcing of long-lived greenhouse gases.

Scientists need to communicate uncertainty to the general population. In March 1951, the Central Intelligence Agency (CIA) secretly warned US officials that a Soviet attack on Yugoslavia should be

considered a ‘serious possibility’. When Sherman Kent, a CIA intelligence analyst, asked his colleagues on the Board of National Estimates what probability they attributed to the likelihood of an attack on Yugoslavia in 1951, he was shocked to hear such a wide range of responses that varied from a 20% chance that the Soviets would invade, to estimates as high as 80%. In 1964 Kent wrote a seminal article on the need for precision in intelligence judgments, *Words of Estimative Probability* (Kent, 1964), in which he cited the ambiguity caused by the words ‘serious possibility’. His essay was an attempt to quantify qualitative judgments and eliminate what he termed ‘weasel’ words. For example, he recommended that ‘probable’ meant 63–87%, and ‘almost certain’ 87–99%. His suggestions were not taken on board, but the general theme behind

his message remains important and relevant today. Since then, the British Broadcasting Corporation (BBC) and the Intergovernmental Panel on Climate Change (IPCC) have also given serious consideration to how to communicate uncertainty.

The IPCC provided guidance notes for lead authors of the IPCC Fourth Assessment Report on addressing uncertainties, and the relationship between their terminology and probabilities is explicated in Table 1.

Terminology	Likelihood of the occurrence/outcome
Virtually certain	> 99% probability of occurrence
Extremely likely	> 95% probability
Very likely	> 90% probability
Likely	> 66% probability
More likely than not	> 50% probability
About as likely as not	33 to 66% probability
Unlikely	< 33% probability
Very unlikely	< 10% probability
Extremely unlikely	< 5% probability
Exceptionally unlikely	< 1% probability

Table 1. Likelihood scale

## Methods

I searched the text of the three books that make up the IPCC Fourth Assessment Report (*The Physical Science Basis* (Solomon et al., 2007), *Impacts, Adaptation and Vulnerability* (Parry et al., 2007) and *Mitigation of Climate Change* (Metz et al., 2007)) and the IPCC Technical Paper ‘Climate change and water’ (Bates et al., 2008) for ‘virtually certain’, ‘extremely likely’, etc. in order to deduce our certainty regarding matters pertaining to water. I considered sea level, flooding, precipitation, and drought. The geographical scope is global.

## Results

The main results of the search are shown in Table 2.

Level of certainty	Sea level	Flooding	Precipitation	Drought
Virtually certain	Will rise beyond 2100 for many centuries.			
Extremely likely				
Very likely	Average rate of rise during the 21st century will exceed the 1961–2003 average rate.		Increases at high latitudes and in some wet tropics and decreases over much of the mid-latitudes and dry tropics.	
Likely		Magnitude and frequency will increase in most regions.		Affected areas will increase.
More likely than not			Increases due to man.	Increases due to man.

Table 2. Uncertainty level regarding sea level, precipitation and drought

## Discussion and Conclusions

We are virtually certain that the sea level shall continue to rise. Flood magnitude and frequency are likely to increase in most regions. It is very likely that precipitation will increase at high latitudes and in some wet tropics and decrease over much of the mid-latitudes and dry tropics. It is likely that drought-affected areas will increase. It is more likely than not that the increases in the frequency of heavy precipitation events, intense tropical cyclone activity and the area affected by drought include an

anthropogenic contribution. The IPCC draw the following conclusions regarding water resources. With respect to water supply, it is very likely (> 90%) that the costs of climate change will outweigh the benefits globally. Current water management practices are very likely (> 90%) to be inadequate to reduce the negative impacts of climate change on water-supply reliability, flood risk, health, energy and aquatic ecosystems. Even with optimal water management, it is very likely (> 90%) that negative impacts on sustainable development cannot be avoided.

### Disclosures

The author has nothing to disclose.

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