Comments on "Have disaster losses increased due to anthropogenic climate change?"

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Bouwer (2011) reviewed recent quantitative studies of observed trends in weather-related disaster losses. The studies cited by Bouwer examined observed trends in economic losses that had been adjusted (normalized) "for inflation and changes in exposure and vulnerability that are related to growth in population and wealth" (Bouwer 2011, 40–41). Most of the studies Bouwer examined found no trend toward larger losses, once the losses had been adjusted for changes in exposure. Bouwer concluded, based on this analysis, that although economic losses from weather-related hazards have increased, "anthropogenic climate change so far has not had a significant impact on losses from natural disasters" (Bouwer 2011, p. 43). The observed increased losses arose principally from increases in population and exposure to hazards.

However, Bouwer's (2011) conclusion can only be valid if two other factors potentially affecting losses have not led to reductions in vulnerability. The first of these factors is the possibility that changes in building techniques (perhaps as a result of changing building regulations) may have reduced the vulnerability of structures to weather-related disasters. Few of the studies analyzed by Bouwer consider this possibility (as Bouwer notes). Yet after major disasters, official enquiries often lead to changes to building (and other) regulations that are intended to reduce the vulnerability to disasters. For Bouwer's conclusion to be correct, we must assume that these changes have failed to reduce economic vulnerability to weather-related disasters. If these measures had been successful in reducing vulnerability, then we should have seen a decline in normalized losses in the absence of any increase in either the frequency or intensity of weather-related disasters.

Further, and of more importance, we must also conclude that any improvements in monitoring and forecasting weather hazards have also had no impact on reducing economic losses from weather-related disasters, if Bouwer's (2011) analysis and conclusions are valid. If weather forecasting improvements had reduced vulnerability, then in the absence of a trend in weather-related disasters, we could have expected a decline in normalized economic losses. Of course, if improvements in weather forecasting have led to reduced economic vulnerability to weather-related disasters, then we could conclude, from the absence of a decline in normalized losses, that climate change has led to increases in some forms of weather hazards and losses.

To summarize, only if improvements in weather forecasting and changes in building regulations and techniques have failed to reduce economic vulnerability to weather hazards can we conclude that the absence of an increase in normalized economic losses is evidence that climate change has not increased losses from such hazards. Otherwise, reductions in vulnerability resulting from improvements in weather forecasting and changes in building techniques or regulations may be offsetting increased losses resulting from climate change. The absence of an upward trend in normalized losses may be due to a balance between reduced vulnerability (from improved weather forecasting and building techniques) and increased frequency or intensity of weather hazards. Unless the possibility that vulnerability has decreased can be dismissed, it is premature to conclude that the absence of an upward trend in normalized losses is evidence that anthropogenic climate change has not had an impact on losses from natural disasters. It seems unlikely that increasingly skillful weather forecasting and changes in building regulations and techniques have not had some impact on reducing economic vulnerability to weather-related disasters.

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Reply

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Nicholls (2011) questions the validity of the main conclusion of my work, that is, that anthropogenic climate change thus far did not have a significant impact on economic losses from natural disasters (Bouwer 2011). His argument is that changes in building techniques and monitoring and forecasting may have reduced the vulnerability to economic damages, thereby balancing a possible increase in either the frequency or intensity of weather hazards. While such effects may certainly play a role, he provides no support that these factors have actually contributed to a substantial reduction in losses over the period of the last decades. Here I will give some reflections on these arguments.

We need not, as Nicholls (2011) argues, dismiss a decrease in vulnerability before we can conclude that anthropogenic climate change has not had an impact on losses from weather disasters. Losses can only have increased due to climate change if there is also an anthropogenic trend of increasing occurrence of the related weather extremes. A human contribution to trends in most large-scale weather-related hazards that were addressed by the studies that I presented, such as extratropical storms and river floods, has, however, not been found (Solomon et al. 2007; Rosenzweig et al. 2007), and for tropical storms it remains uncertain if activity has exceeded natural variability (Knutson et al. 2010). My statement that anthropogenic climate change thus far did not have a significant impact on economic losses from these extremes is therefore robust in my view. I did provide the caveat that for smaller-scale weather extremes for which anthropogenic changes have been established (such as heat waves, droughts, and heavy precipitation events), such impacts may be found, but studies of long time series of damages are rarely available for these extremes.

I agree with Nicholls that it is unlikely that weather forecasts and changes in building regulations have not had any effect on economic vulnerability to natural disasters. The challenge, however, is to find out *how large* the effect on actual economic losses actually has been over longer periods of time. Such quantification would certainly help to support evidence-based policy for vulnerability reduction. However, few quantifications of the avoided losses resulting from vulnerability reduction are available (Benson and Twigg 2004), and economists have resorted to risk modeling or impact-based historic analyses to estimate such benefits (Mechler 2005). Measures for protecting buildings and home content are most often taken after large and rare events, and certainly are not taken everywhere around the world. Government-initiated programs, such as improved building codes in Florida, for instance, have lead to actual reductions in vulnerability to hurricanes only recently (Hallegatte 2008; Pielke et al. 2008). Moreover, direct economic losses from large weather disasters have increased at a rate of about 125% per decade since the 1970s, which is much larger than the average rate of global gross domestic product (GDP) growth (Bouwer et al. 2007). This indicates that a rapid trend of increasing exposure is the main cause for rising losses with urbanization, and an increasing concentration of people and assets along the coasts are the main drivers. Clearly, before vulnerability reduction can turn this trend around, substantial efforts over longer periods of time are needed.

Monitoring and forecasting weather hazards may certainly help to reduce the loss of life. While the number of deaths resulting from floods has apparently increased at a lower rate than economic losses (UN ISDR 2009), it is unsure to what extent forecasting may have reduced economic losses, especially in the largest and most extreme damaging events.

As I have suggested in my article, the match between the loss record normalized for nonclimatic drivers of risk (i.e., changes in exposure and wealth) and the geophysical record of observed weather extremes, such as tropical cyclone landfalls and flood occurrence, provides a good test for the validity of the analysis. Some studies have tested such matches (e.g., Pielke et al. 2008), but more can be done in order to find out the exact causes of variations and trends in disaster losses. Importantly, and as I have pointed out earlier, loss data are far from accurate, which complicates the detection of the relatively subtle signals of anthropogenic climate change and risk reduction. Even if economic losses from certain weather extremes increased, it is unlikely that they would be observed in the loss data, because natural variability and other drivers dominate this loss record, which has high uncertainty ranges. For example, a recent study using climate model results shows that anthropogenic changes in U.S. hurricane losses can be detected only

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after some 260 yr from now, or at the earliest after some 120 yr (Crompton et al. 2011). The first signals of changing weather disaster risks will therefore likely come from geophysical data, not from loss data.

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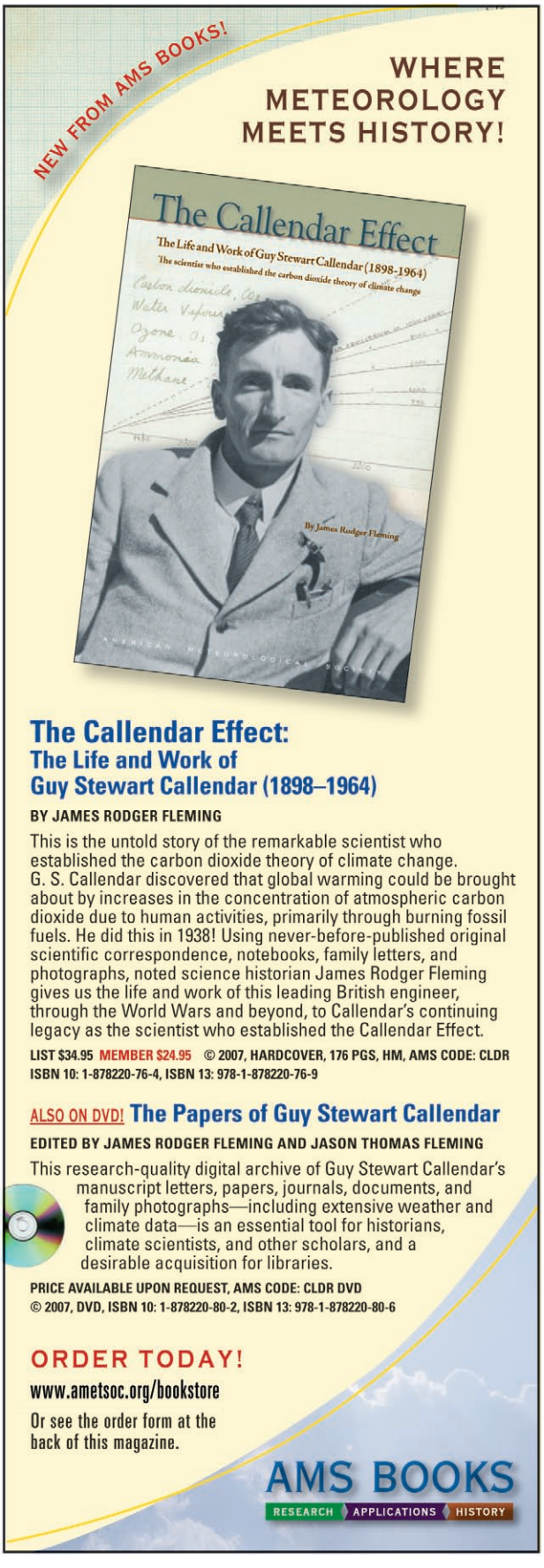

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