Summary

This thesis, titled “Disasters and climate change: analyses and methods for projecting future losses from extreme weather”, examines to what extent anthropogenic climate change will result in more damage from weather-related natural disasters during the next decades, in comparison to non-climatic drivers of risk. A review is made of the scientific literature on historic disaster losses, as well as projections of future disaster losses. Also, an analysis is made of changing risks from flooding of rivers for a case study area in The Netherlands, and their climatic and socioeconomic causes. From this research I conclude the following:

Past increases in weather disaster losses are due to non-climatic drivers: Economic losses from weather disasters (including floods, windstorms, tornadoes, thunderstorms, wildfires and droughts) have undoubtedly increased, but no scientific study of loss records has identified anthropogenic changes in extreme weather as the main driver for the observed trend. The observed loss increase is caused primarily by increasing exposure and value of capital at risk. The overview of studies presented in this thesis shows that loss records that were corrected for changes (increases) in population and capital at risk show no long-term trends that can be attributed to anthropogenic climate change. That no trend has yet been found in corrected losses follows logically from the fact that anthropogenic changes have only been detected for a few weather extremes.

Projections of future weather risks need a comprehensive approach: Most studies have not sufficiently taken into account the consequences side of risk. The role of economic growth and population growth is in most instances ignored. This thesis proposes a comprehensive approach, that combines scenarios of changing exposure with a catastrophe model. The approach is aimed at quantifying the bandwidth of the possible development of future weather risks, in this case flood losses. It seems warranted to expand the efforts in projecting and analysing the role of exposure in future disaster risks.

River flood losses could increase more rapidly than windstorm losses: The future increase in losses from river flooding due to anthropogenic climate change may be higher than the increase in windstorm losses. This expectation is based on a comparison of loss projection studies. The difference in the increase in risk is due to the difference in projected changes in the river flood and windstorm hazards, that show larger increases in flood frequency compared to windstorm frequency or intensity. Also, there is more certainty that intense precipitation will become more frequent. Projections of changes in floods are somewhat more robust compared to projections of windstorms. That this effect will be found in loss records in reality is
uncertain, given that flood losses are often not well recorded. Also, differences in exposure to storms and floods, as well as risk reduction measures, may differentiate trends in both types of disaster losses.

Through an analysis of historic river discharges and time series of large scale atmospheric circulation and sea-level pressure, it is shown that variations in high river discharges in Europe in winter are caused by variations in the frequency of west atmospheric circulation. High river discharges are found to be more sensitive to these variations than the mean discharges. If anthropogenic climate change would lead to an increasing pressure gradient in the northern hemisphere, flood probability in northwest Europe could increase. The analysis in this thesis shows that some periods, in particular the 1990s, stand out in terms of high peak discharge occurrence in northwest Europe, but such periods have also occurred earlier in the record, in particular during the 1910s and 1920s.

**The impact of climate change on weather losses will remain small in coming decades:** For a case study on flooding of the river Meuse in The Netherlands, future impacts on river flood risk have been separated for projected climate change and exposure. It is found that anthropogenic climate change may lead to a substantial increase in potential flood losses for this case by the year 2040 (up to 201%), that is about as large as the increase in exposure due to land-use change and increasing value of capital combined (up to 172%). All published projections of future weather risks that have been assessed in this thesis show increases in losses due to anthropogenic climate change by the middle of this century. However, for the period up to 2040, the contribution from increasing exposure and value of capital at risk according to current studies is substantially (about 2-10 times) larger than the contribution from anthropogenic climate change. Given the fact that loss events are stochastic, and that their occurrence varies over time due to natural climatic variations, the relatively small signal from anthropogenic climate change until the year 2040 is likely to be lost among other causes for increasing and varying losses, at least for storms and river floods.

**Implications for climate policy:** Attribution of increases in disaster losses to anthropogenic climate change will remain very difficult in the decades to come. There are other impacts from climate change, apart from changed impacts of extreme weather, that should be the primary motivation for the reduction of greenhouse gas emissions. Adaptation to changing risks seems the most effective way of reducing the increasing impact from extreme weather in the short term, up to the middle of this century. Therefore efforts in climate policy and other policies should be focussed on better understanding the actual causes of risk, and on promoting adaptation also in the short term, in addition to efforts for emission reduction.