Good management of natural resources, such as water, is beneficial for the well-being of communities and societies. However, projected population growth, economic growth and climate change complicates the management and threatens to increase the exposure of people and assets to water-related risks like drought and flooding. In response to these projected changes, adaptation measures in water management are being developed to reduce the vulnerability of communities and households to these risks.

This thesis investigates the extent to which several local-scale adaptation measures can reduce communities’ vulnerability to projected impacts on water resources (relating to flooding and drought) resulting from socio-economic and climate change trends. Additionally I assess upstream- and downstream effects when local-scale measures are upscaled and implemented at larger geographic scales. The research was based on four case studies carried out in Kenya, Ethiopia, Peru and Vietnam. Here, a novel approach was used which combined household survey data and measured and modelled hydrological data. Additional to the case study research, two literature reviews were performed on the costs and effects of water harvesting systems on supplying additional water in semi-arid regions for domestic uses and for agricultural uses respectively.

For the assessment of local-scale adaptation measures the concept of vulnerability was applied using three types of approaches: (1) single indicators, such as income, number of people working in agriculture, distance to water, education level, etc.; (2) indices, which are composed of several measurable indicators; (3) and, a risk based index ‘Expected Annual Damage’ for exploring vulnerability to flooding. This thesis shows that the suitability of an approach is dependent on the goal of the vulnerability analysis. For the evaluation of the effectiveness of a measure to reduce exposure, simple information on access to water or exposure to flood could be sufficient. For a more complex prioritisation of different types of adaptation measures, which may target different components of vulnerability (exposure, sensitivity, adaptive capacity), more complex indices are more suitable. Such indices indicate how the different components of vulnerability are influenced by measures, and how this affects the household vulnerability.
Linking hydrological data to socio-economic vulnerability in the case studies has proven to be a powerful approach in assessing the effects of adaptation measures to reduce vulnerability to climate change. It allows for studying the potential effects of adaptation measures on vulnerability and socio-economic factors, as well as the ability to assess which socio-economic factors play an important role in determining the sensitivity and adaptive capacity of a community. For instance, the Peruvian case study shows that household vulnerability to drought is dependent on household water entitlement, area of irrigated land, income, and education. The vulnerability approaches of this thesis can be applied to other case studies, but they should be adjusted in order to fit the local circumstances.

The results of the research in Ethiopia and Kenya show that households using community based adaptation measures such as sand dams (a specific type of water harvesting measure) reduced the time they spend on collecting water, and increased overall water use. Furthermore, the Kenyan case study shows that household income rose from $210 to $336 after implementation of water harvesting measures. Analysis of large scale implementation of these local-scale measures revealed that downstream impacts are limited, both under current and projected future climatic circumstances. The average seasonal flow is reduced by 2 to 28%, depending on the number of dams and climate scenario that are used in the model. The number of dams varies between 200 and 2200, which supply water to respectively 75,000 and 1.5 million people.

A review of current literature indicates that water harvesting systems can supply water for prices ranging from $0.40 to $8.73 per m$^3$ over their lifetime for different techniques, assuming that systems are recharged only once per year. Results from the literature also show that water harvesting leads on average to an increase in crop yield by 78%.

Local-scale flood measures were found to be promising in comparison to large-scale measures. The analysis in Ho Chi Minh City, Vietnam, shows that benefits/cost ratios for local-scale measures range of 0.33 to 0.72 for current circumstances compared to 0.12 to 0.23 for large-scale measures. When including scenarios of climate and socio-economic change the ratios increase to a range of 0.76 to 1.44 for local-scale measures, compared to a range of 0.29 to 0.56 for large-scale measures.

Besides quantitative evaluations of the performance of local-scale measures, this thesis also shows that successful implementation of such community-based measures can be achieved using participatory approaches, where local knowledge and scientific information are combined. This is seen in the cases studies in Peru, Vietnam and
Ethiopia where these types of measures have been successfully implemented by communities.

The results of the research show that local-scale or community-based adaptation can be an attractive option to reduce impacts from climate change to communities and to reduce the effect of changes in exposure to water related risks due to socio-economic developments. They consist of low-cost systems with easy maintenance that can be developed, constructed and operated with a high degree of community involvement, which improves their durability. They have a positive effect on water supply and flood protection and reduce the vulnerability of households and communities to water risks. These findings imply that local scale measures, such as water harvesting, should be included in strategic water management plans in addition to the more traditional large-scale measures (such as large reservoirs). Government agencies, donors, and other implementing agencies can then consider a wider array of possible measures in an early stage of decision-making. In these evaluations of alternative investments in water management they should consider local circumstances and indicators of social and economic conditions. This includes the participation of the local communities and stakeholders, besides experts. Such a participatory process itself also strengthens the capacity of stakeholders to understand the challenges and the need to take action. The local stakeholders can also help to develop adaptation measures that are effective in their specific environment. If implemented correctly, local-scale adaptation measures can play an important role in fulfilling the Sustainable Development Goals in the coming years.