Geophysical Research Abstracts
Vol. 13, EGU2011-10928, 2011
EGU General Assembly 2011

Integrating regional development to flood risk assessment

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According to the International Disaster Database, flooding is the type of natural disaster that affected the highest number of people worldwide in the last century (1900-2008). In the course of the 20th century in Europe floods caused 9000 fatalities, affected 1 Mio residents and lead to 9 Bio € in economic losses apart from severe environmental damages. One of the main reasons is change of land use from agricultural to industrial and residential areas in former flood plains, leading to a significant increase in physical and human exposure and consequently higher damage potential. This paper aims to analyse consequences of hinterland development on flood vulnerability and flood risk using the example of an Austrian municipality.

As residential areas in the municipality of Gleisdorf were exposed to flooding of the local river system, a flood protection scheme was implemented in 1999. The protection measures, designed to resist a 100-years flood, include dykes, floodwalls, and a flood retention basin. Since then, hinterland development continued, and large parts of the former floodplain were transformed into industrial and residential areas. As a consequence, the numbers of exposed objects and people at risk increased substantially.

For flood hazard assessment, hydrographs of different return periods are generated using a rainfall-runoff model, also considering uncertainties in model parameters and rainfall patterns. The resulting hazard data base includes simulated inundation lines, water depths and flow velocities. In the frame of vulnerability assessment two different stages of land use are analysed: (1) the development status prior to the implementation of flood mitigation measures in the year 1999, and (2) after a decade of development in the former flood plain area in the year 2008. Exposed objects are identified and categorized for both points in time using regionally adapted damage functions as derived from local damage reports. Economic consequences and monetary damages are analysed under special consideration of residential buildings and industrial sites. Applying a micro-scale flood risk assessment procedure considering economic criteria, the overall risk for the flood prone area is analysed by aggregating the damage potential for all individual objects.

Results clearly indicate the increase in expected annual losses due to the increased vulnerability triggered by hinterland development. The residual risk which remains after implementing flood protection measures (i.e. emerging from events exceeding the design events, insufficient maintenance, unexpected failure, etc.) outlines a remarkable increase. If no mitigation measures were implemented, the expected annual losses would be dramatically higher. This increase of the overall expected annual losses represents the tremendous general increase of social vulnerability in the course of one decade. When implementing the flood protection scheme, the increase of flood risk could have been avoided, and therefore overall flood risk could have been reduced, e.g. by applying a building ban on former flood prone areas.