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A transdisciplinary approach for flood hazards in mountainous karst areas of Morocco

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The particular geological, hydrogeological and geomorphological setting of the karst areas of the Drâa basin in the High Atlas mountains of Morocco cause them to be very vulnerable to hydrological extremes, in particular floods. Geological boundaries between limestone and basalt, steep landslide- and debris flow prone slopes, coarse-grained, highly porous river beds, large subsurface reservoirs with high potential discharge rates and infrequent, high intensity rainfall or snow-melt cause these karst areas to be subject to a particularly high flood risk. Flood waves usually only develop after a long lag time due to the high infiltration and storage potential of channel beds and interflow areas such as scree slopes. Extensive scree slopes are a product of high weathering rates of limestone under both conditions of extreme temperatures, low humidity and frequent freeze-thaw cycles. In addition, agriculture and land use change have degraded the karst areas. The most important driving forces for degradation include permanent over-grazing even during droughts and the use of firewood by a continually growing population. Large scale degradation of natural vegetation has occurred mainly in the oro-Mediterranean zone, i.e. between 2600 - 3400 m where there has been a particular decrease in the density of perennial grasses with a sucession of cushion shrubs. The combination of this degradation and deforestation in the higher zones has resulted in unimpeded erosion and the development of fast discharges on the highly exposed slopes, which in turn has increased the production of scree slopes and fluvial source material.

The karst groundwater reservoirs are very extensive and largely unknown in dimension, yet a large percentage (approx. estimated 70%) of surface water is directly lost to these. Especially after long lasting rainfall or extreme snow melt events, rapid discharge emerges from the karst aquifers. Once intermediatory reservoirs such as scree

slopes or river beds are filled, discharge emerging at the surface develops into sharp and short duration flood waves. After cessation of rainfall, the flood peaks diminish very rapidly again as the water rapidly infiltrates back into these interflow areas and the deeper karst reservoirs. In the northern Oulilimt catchment, there are large karst springs that emerge from the very steep and long sheets of limestone. They join to form larger rivers that are also fed by snowmelt. Under such circumstances, flood peaks can be augmented very rapidly. In terms of flood forecasting and hazard zone definition, an interdisciplinary approach is a pre-requisite and in the frames of the IMPETUS project (an integrated management project dealing with the efficient and sustainable use of freshwater resources), the cooperation extends across Geography, Geomorphology, Geology, Hydrogeology, Soil Science, Meteorology, Agricultural Sciences and Botany.