Preparing for hydrological hazards in Styria under conditions of uncertainty

Main Supervisor: **Oliver Sass** [**showcase 1**]
Research field "Meteorology and hydrology: Climate change geomorphology and natural hazards"
Research question 2 | Cluster 2
Links to showcases Bednar-Friedl 1, Foelsche 1, Kirchengast 1, Maraun 1+2, Meyer 1

Background: Adaptation measures towards water-related hazards in alpine regions require knowledge of future frequency and magnitude of catastrophic torrential events, affected areas, and the development of damages. Regional climate scenarios suggest the possibility of intensified rainstorm events which might trigger natural hazards (e.g., Kendon et al, 2014). Regional effects of climate change in alpine regions are, however, subject to a broad uncertainty range (Gobiet et al., 2014), especially for precipitation. Furthermore, higher precipitation and runoff do not necessarily effect in severe torrential flooding as questions of sediment availability have to be considered (Recking, 2012).

Goal: The focus is on damages related to sediment transport in torrential catchments of Styria. The aim is the setup of a coherent model chain covering precipitation–runoff relationships, hydraulic models, runoff–sediment transport models, impact/vulnerability models and scenarios of economical damage. One overarching aim is to focus on propagating uncertainties to deal with the practitioner's dilemma: which consequences should be drawn from a set of scenarios probably ranging from 0 (nothing will happen) to highly threatening worst case scenarios? To achieve this aim, we will follow defined "storylines" of future development combining decision- and scenario-driven views and considering robust decision making pathways. The project contributes to Cluster 2 (adaptation) with a local emphasis, dealing with uncertainties and the implications for adequate decision making.

Methods and disciplinary background: Several steps are necessary to translate future precipitation scenarios into damages caused by natural hazards. Steps 3, 4 and 7 are the core part of the planned thesis, while 1-2 and 5-6 will draw on cooperation within and outside of the DK: (1) Future frequency and magnitude of heavy precipitation events in Styria; (2) Consequences for torrential runoff derived from precipitation-runoff models currently being set up in the ACRP-project RunSed-CC; (3) Consequences for flood levels and sediment hazards derived from hydraulic and geomorphological models, using models of sediment transport and landscape development (e.g., Telemac, CAESAR, LandLab) and existing field data; (4) Conversion to damage using published vulnerability curves; (5) Reference to selected typical valleys of Styria using building cadastre; (6) Comparing the ensuing additional losses to the costs of hard protection or alternative measures and discussing robust adaptation pathways; (7) Assessing uncertainties in this process chain and discussing the normative implications.

References:

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Impact of climate change on moisture levels and the decay of cultural heritage

Main Supervisor: **Oliver Sass** [**showcase 2**]
Research field "Meteorology and hydrology: Climate change geomorphology and natural hazards"
Research question 2 | Cluster 1
Links to showcases Bednar-Friedl 1, Kirchengast 1, Maraun 2, Meyer 1

Background: Damage to historical stonework in Europe is thought to increase due to climate change, mainly caused by increasing mean precipitation and air humidity (Sabbioni et al., 2012). Both may lead to heightened moisture levels within the stonework and inside historical buildings. However, the impact of regional and local climate change on moisture levels is not straightforward as higher temperatures and changing insolation or wind might lead to complex responses. What is more, stone moisture is still a parameter that is hard to measure in the field (Moses et al., 2014).

Goal: We intend to investigate stone moisture at cultural heritage sites in Austria (supplemented by further sites across Europe) by means of moisture sensors and numerical simulations. The aims are to assess (1) how moisture levels and fluctuations differ between meso-climates; (2) the according sensitivity of this parameter to climate change in different regions of Austria, (3) how changing moisture regimes will affect weathering of cultural heritage sites and (4) which consequences for conservation strategies need to be drawn considering economic and normative viewpoints. The project mainly contributes to DK Cluster 2 (adaptation), investigating the impact of hydro-meteorological changes on cultural heritage sites and the associated losses. We hypothesize that these changes will be due to shifts in mean climate conditions rather than extreme events, whereby complex thresholds (combining temperature/precipitation/humidity) might be crossed. There are links to DK Cluster 1 regarding the quantification and attribution of climate change induced damages, their cost, and how to cope with the risk of losses as part of the transition towards a climate-robust society. Economic and normative questions arise from the problem of assigning monetary values to intangible cultural assets.

Methods and disciplinary background: The approach will focus on heritage sites in sandstone and arenitic limestones. The chosen sites follow a transect from the British Isles (Belfast, Oxford) through Middle Europe and Austria (Nuremburg, Vienna, Graz) to the Mediterranean (Cyprus) and possibly arid regions (Jordan). The selection of sites is influenced by existing cooperations with collegues from the weathering / rock conservation community. The measurements will be carried out using different types of rock moisture sensors. We will use numerical simulation software from building physics to simulate moisture fluctuations based on current climatic input data, validate this data using our measurements, and modify the input data according to climate change scenarios. This combined measurement and simulation approach will allow estimates of future moisture regimes and their implications, including robust adaptation options that are beneficial under a range of climatic and non-climatic changes.

References:

Moses, C., D. Robinson, J. Barlow. 2014. "Methods for measuring rock surface weathering and erosion. A critical review." Earth-Science Reviews 135: 141-161.

Sabbioni, C., P. Brimblecombe, M. Cassar (Eds.). 2012. "The Atlas of climate change impact on European cultural heritage. Scientific analysis and management strategies." Anthem Press, London.