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Flood risk under climate and land use changes – a coupled modelling framework in an alpine study area

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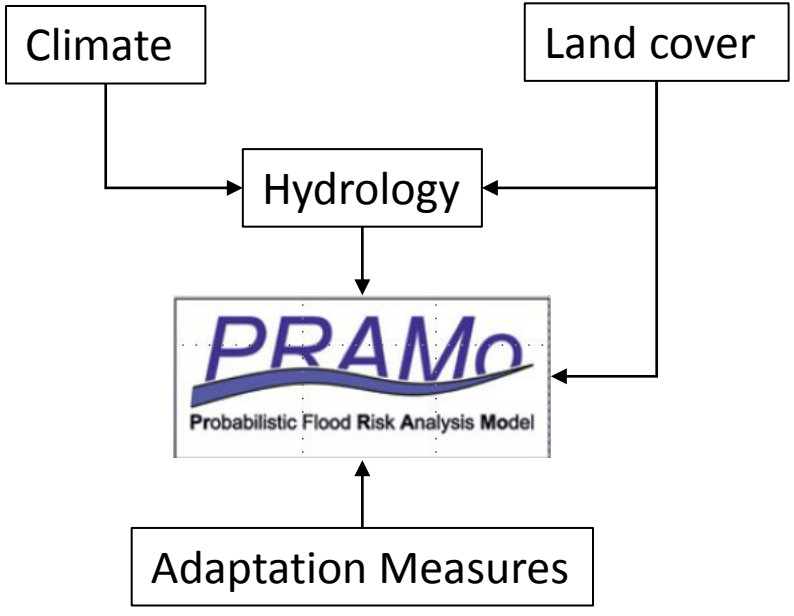
General Concept



- How may flood risk change in future due to changes in climate and land use?
- How can flood protection measure contribution to reduce risk?
- Present (1987-2016), near future (2021-2050) and far future scenario (2071-2100)

Study Area

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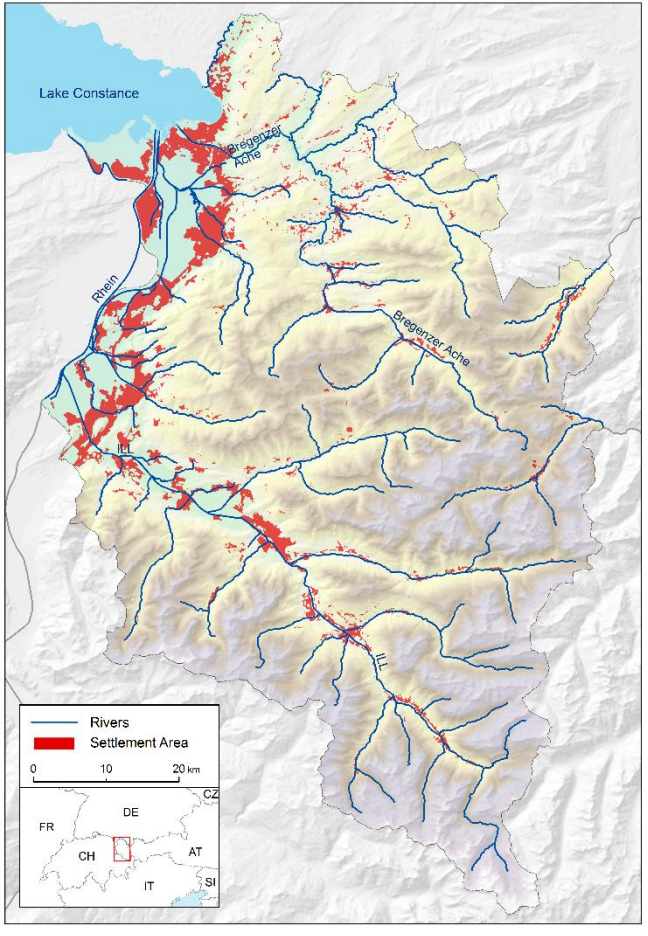
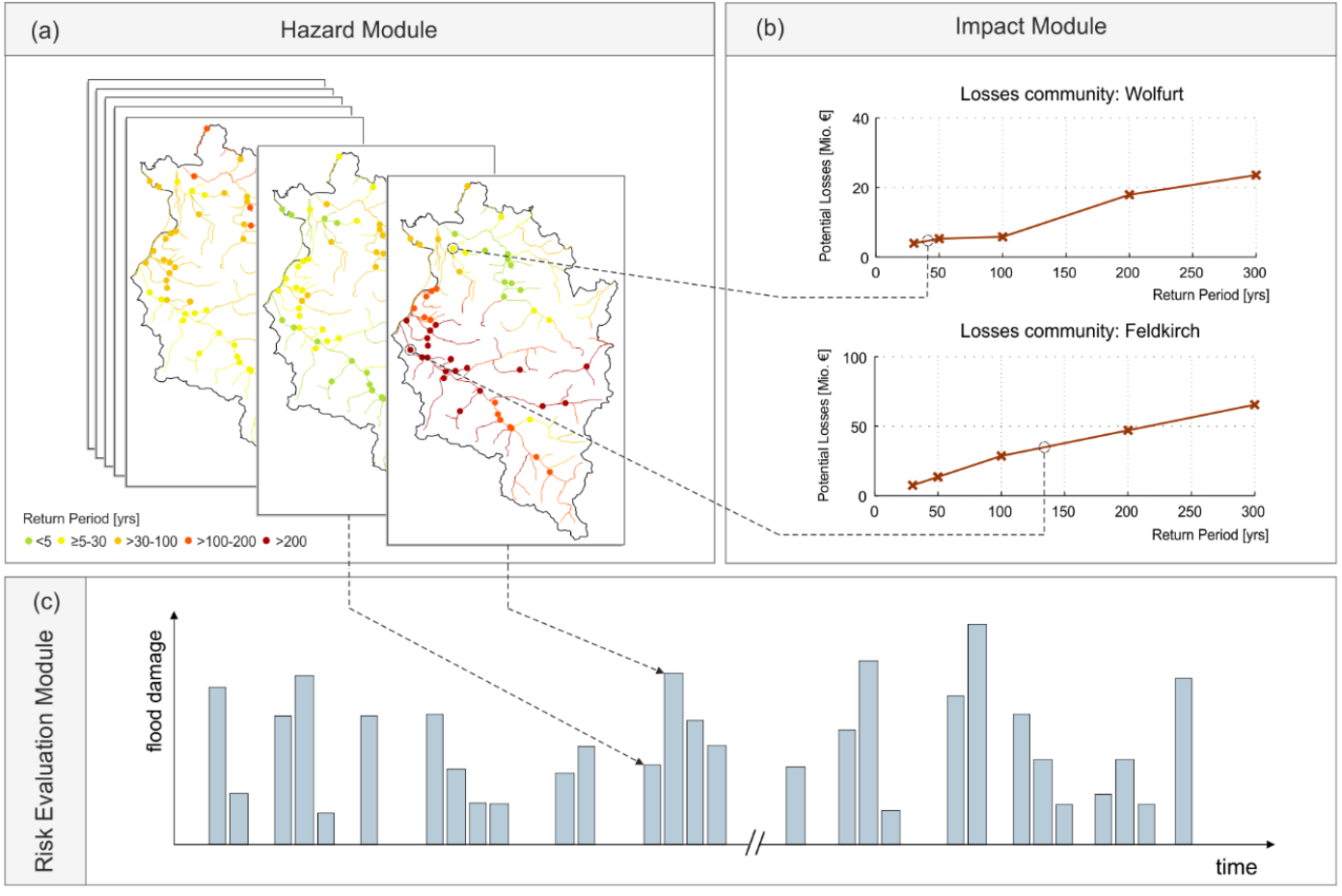
- Vorarlberg, the westernmost province of Austria
- Approximately 2600 km^2
- Mountainous landscape ranging from 400 up to more than 3000 m a.s.l.
- Forests cover about 40% of the study area
- Settlement areas are concentrated in the valley floors



Probabilistic flood risk model PRAMo



(Schneeberger et. al. 2019)

Changes in the hydrological system

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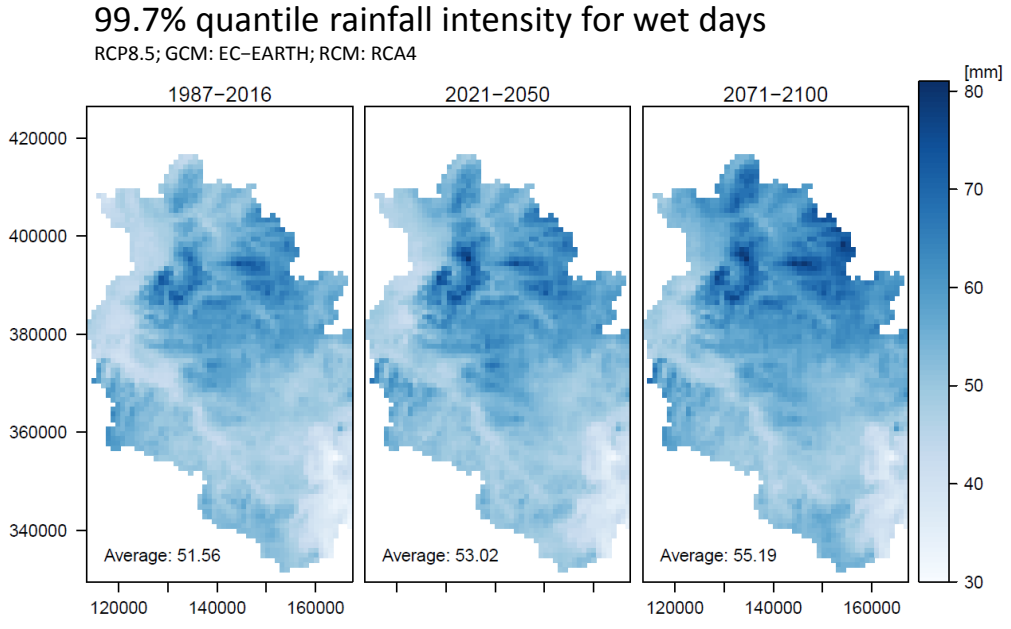
Climate boundary conditions

ÖKS15, Austrian climate change scenarios

Present: 1987-2016
Near future: 2021-2050
Far future: 2071-2100

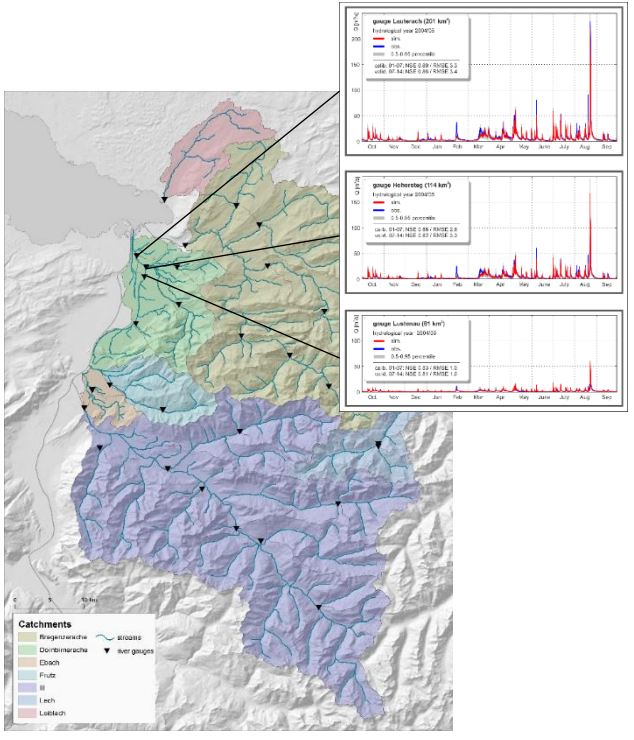


Changes in the hydrological system

Modelling of the hydrological response for the three time periods and entire river network via semi-distributed RR-Model (HQsim)

Concept of Hydrological Response Units (HRUs) with dynamic land use classes, to address land cover change

- Calculation of hydrological response for each land use class separately, according their parametrisation (e.g. evapotranspiration)
- Total response is given as fraction of each class
- Fraction of each class can changed during model run



Changes in land cover

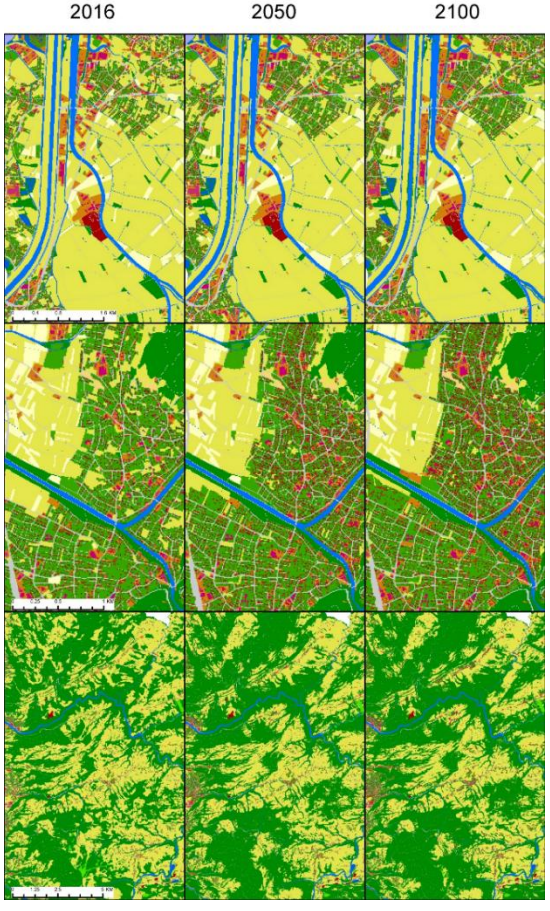
Quelle: http://vogis.cnv.at

Intensive landscape change in the last decades, with two key developments:

- Spreading of settlements (see example “Dornbirn”)
- Forest expansion at the expense of pastures and meadows

Changes in land cover

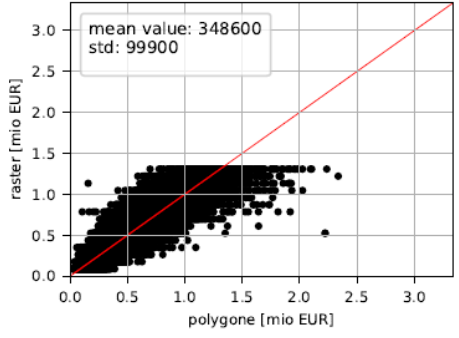
- Spatially explicit land use modelling (Dyna-CLUE) with a grid resolution of 10 meter
- Special focus on settlement development with different build-up classes (e.g. single-/multi family houses; industry, trade & service)
- Four different socio-economic pathway scenarios up to the year 2100, based on the Austrian “Conference” on Spatial Planning, ÖROK (risk, competition, security and growth)



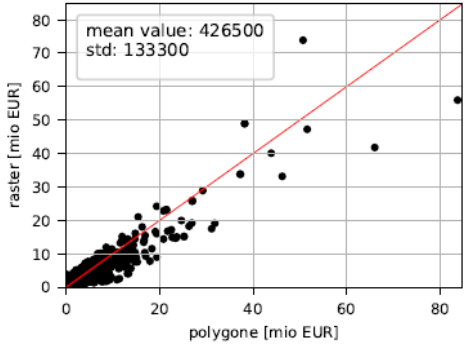
Asset assessment

Average monetary values of build-up pixels classes are derived by object based insurance values (polygons).

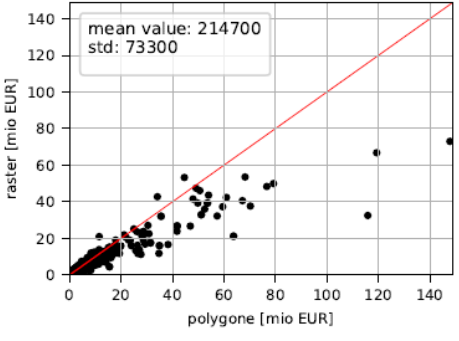
single-family houses



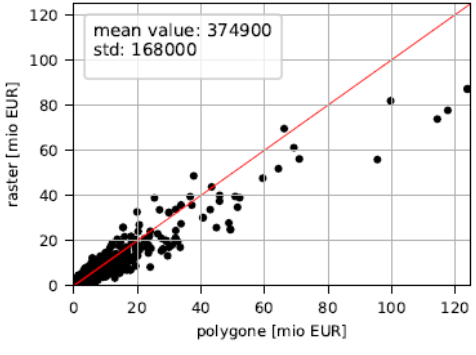
multi-family houses



Industry and storehouses

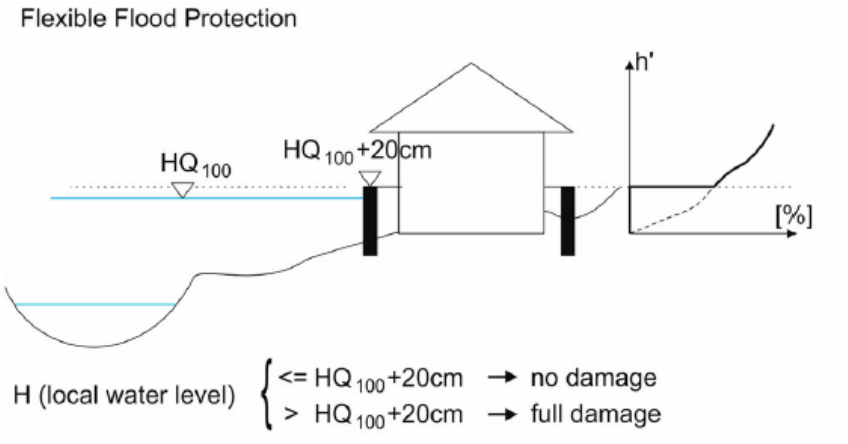


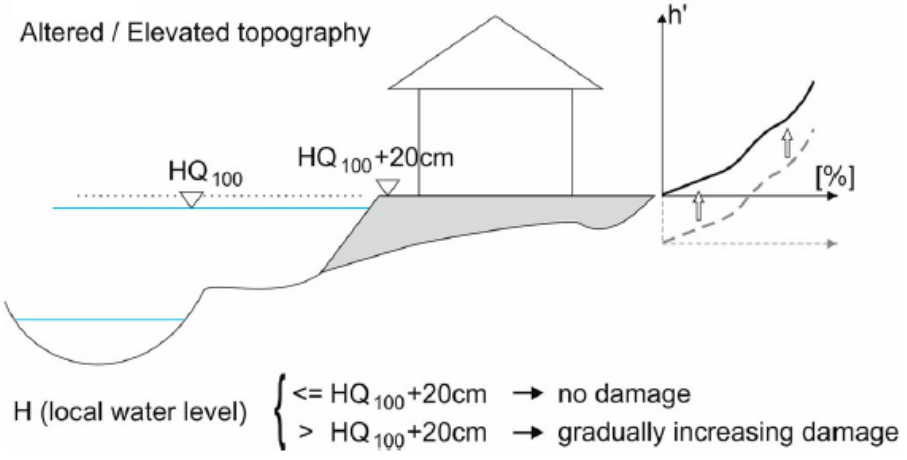
trade and services



Object based flood protection measures

Theoretical approach, inspired by legal definitions of the Austrian province “Upper Austria” (LBGl. Nr. 35/2013 § 47).





(Achleitner et al. 2016)

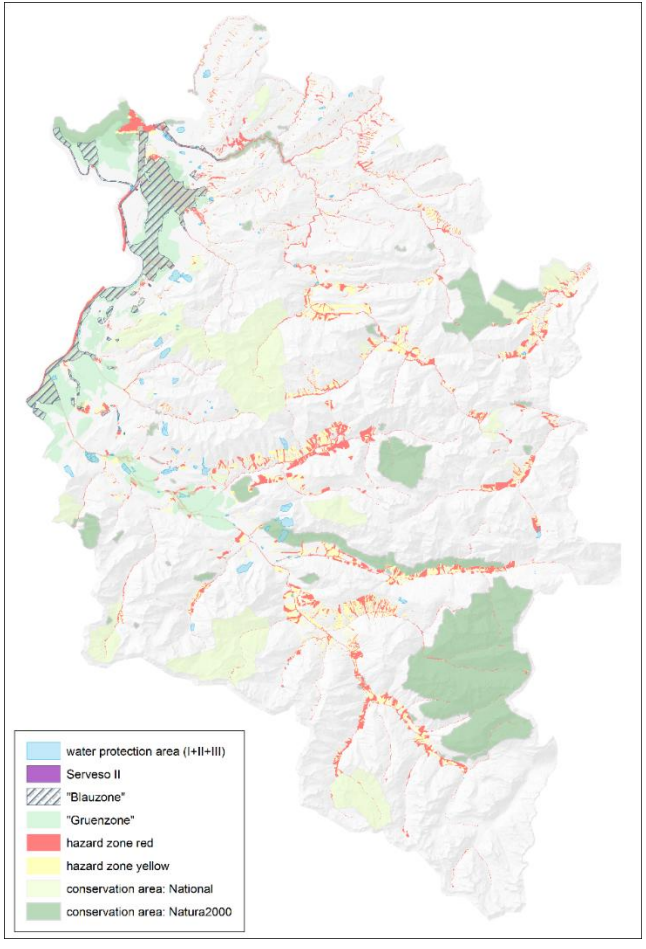
Spatial planning measures

Development of different spatial planning scenarios to restrict settlement/building development:

Baseline: Consideration of present legal situation

Adaptation: Present legal situation + strictly no development in the ‘yellow‘ risk zone

Extreme: No restriction at all



Preliminary Results

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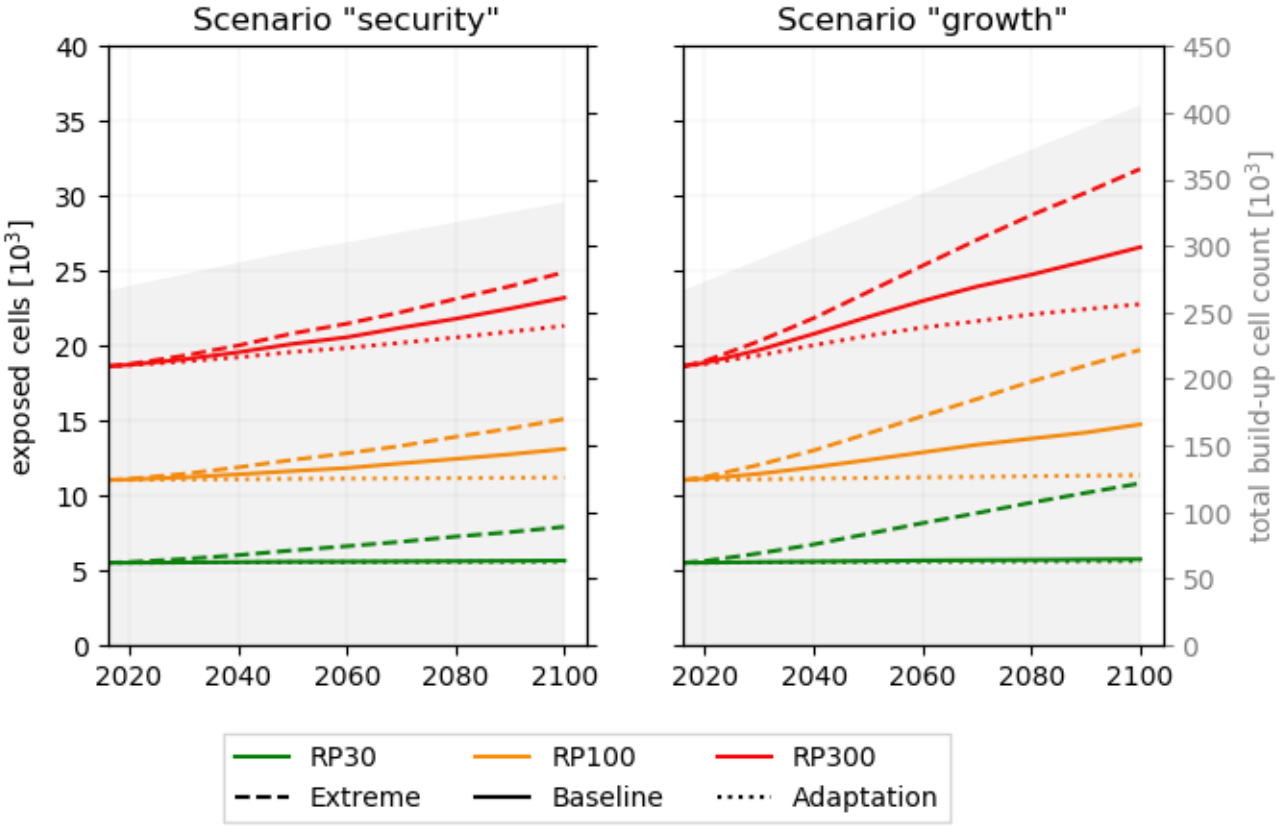
Development of exposition based on “homogeneous” flood scenarios



Further Outlook

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Next Steps:

- Calibration of the hydrological model for a reference periods
- Hydrological simulation of the climate change scenarios (RCP4.5 and RCP8.5), including the land use change scenarios
- Estimation of corresponding risk-curves, with underling plausible heterogeneous flood scenarios, based on PRAMo

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Thank you.

References:

Achleitner, S.; Huttenlau, M.; Winter, B.; Reiss, J.; Plörer, M.; Hofer, M. (2016): Temporal development of flood risk considering settlement dynamics and local flood protection measures on catchment scale. JRBM. DOI: 10.1080/15715124.2016.1167061.

Schneeberger, K., Huttenlau, M., Winter, B., Steinberger, T., Achleitner, S. and Stötter, J. (2019) A probabilistic framework for risk analysis of widespread flood events: A proof-of-concept study. Risk Analysis 39, 125–139. doi: 10.1111/risa.12863.

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