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Towards impact-based warnings

Evaluating an automated impact-based warning tool to assess building damages during winter storms

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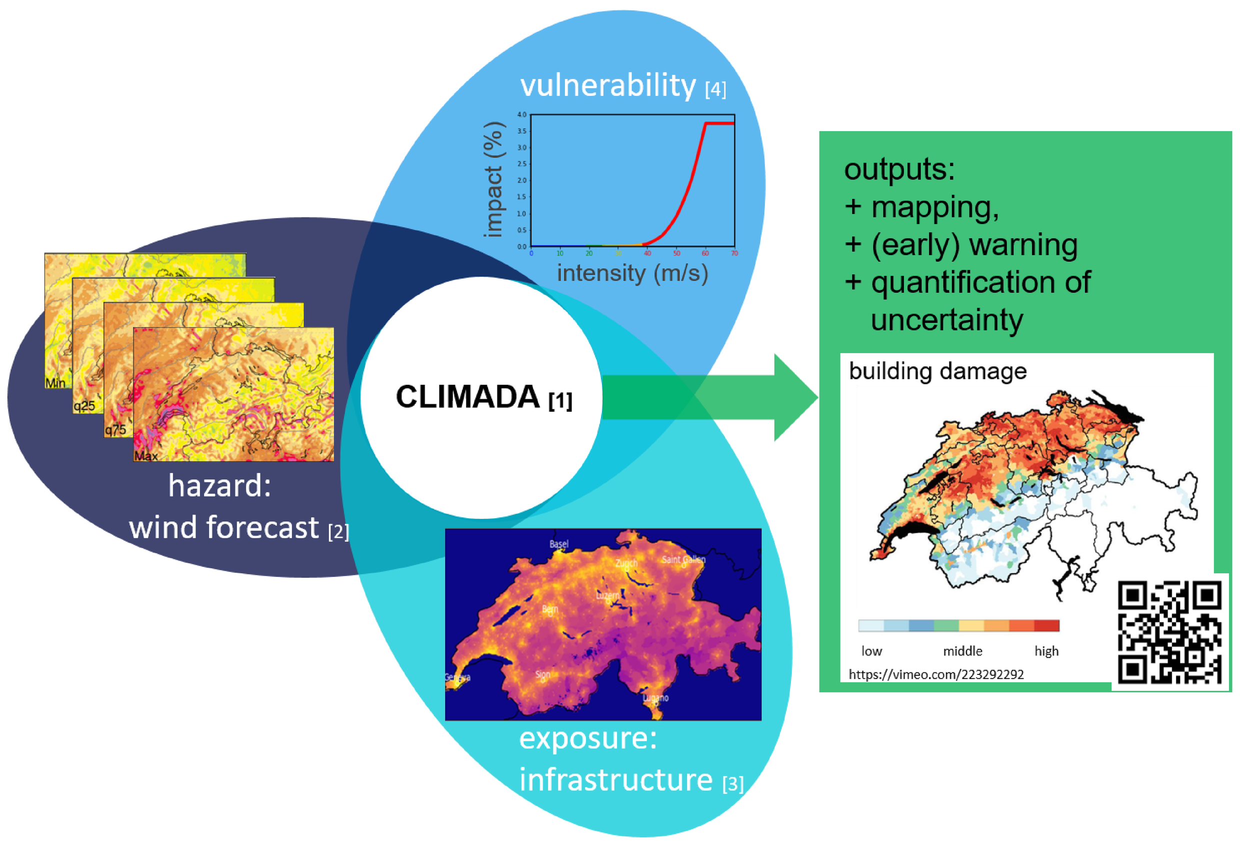
Impact-based warnings have been gaining the attention of National Meteorological and Hydrological Services to assess their potential to provide a more effective collaboration with disaster reduction and civil protection agencies, as well as to better inform the public and stakeholders. It is currently a common practice to analyse the hazardous meteorological and hydrological components together with the vulnerability of the targeted exposure to assess weather related impacts and resulting warnings. Advanced quantitative processes involving impact models using geolocated vulnerability and exposure datasets are still a challenge for many agencies due to missing data and validation strategies. In this work we investigate the potential of an impact model designed to approximate building damages by considering the strongest winter storm in Switzerland since 1999, storm Burglind.

IMPACT MODEL

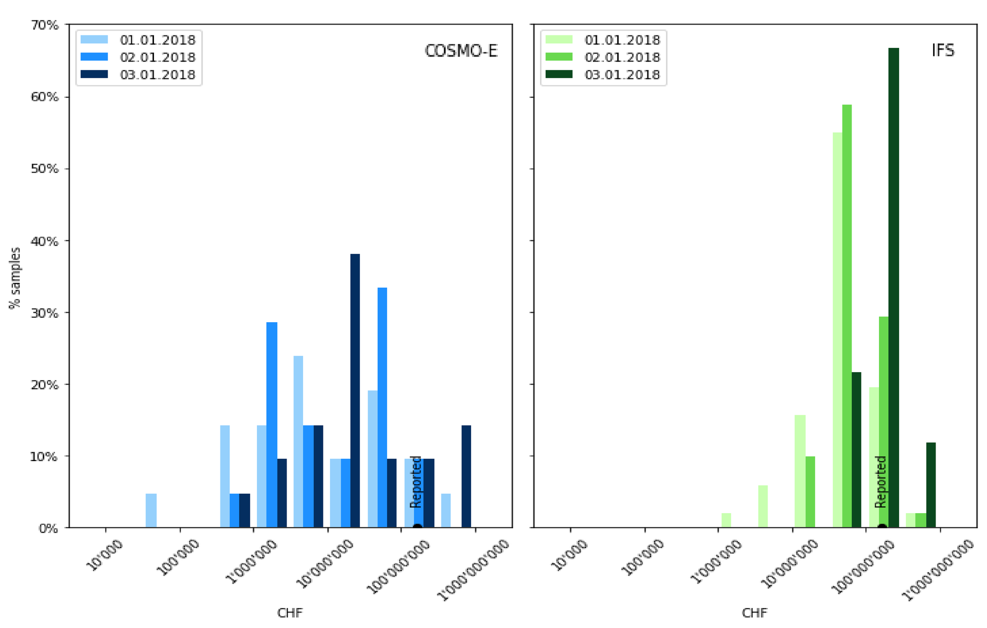


Natural risks emerge through the interplay of climate and weather-related hazards; the exposure of goods or people to this hazard; and the specific vulnerability of exposed people, infrastructure, and environment. CLIMADA[1] combines these components to obtain geographically specific risk metrics and uncertainty estimates by quantifying risk as follows:

$$
\begin{aligned}
risk &= probabilty\ x\ severity \\
&= probability_{hazard}\ x\ (intensity_{hazard}\ x\ exposure\ x\ vulnerability)
\end{aligned}
$$

In this analysis we consider wind gust ensemble forecasts of two models, IFS and COSMO-E[2], hitting Switzerland's infrastructure during storm Burglind the 3rd January 2018. The infrastructure is modelled using the LitPop model[3] and its vulnerability to wind storms is approximated according to Schwierz et al. 2010[4]. We compare the resulting damages to the ones reported by the Swiss cantonal building insurers.

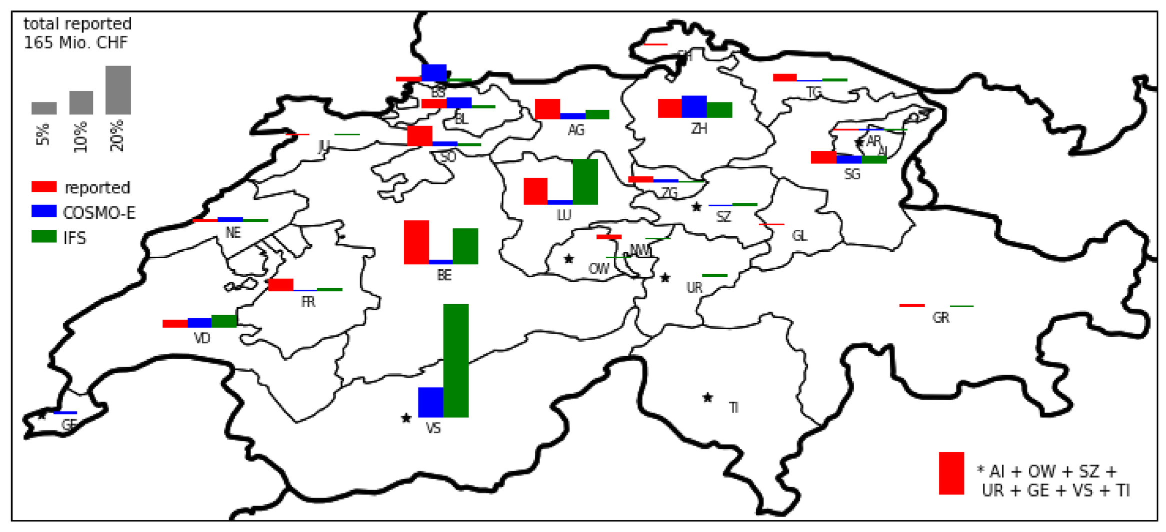
TEMPORAL EVOLUTION OF FORECASTED DAMAGE



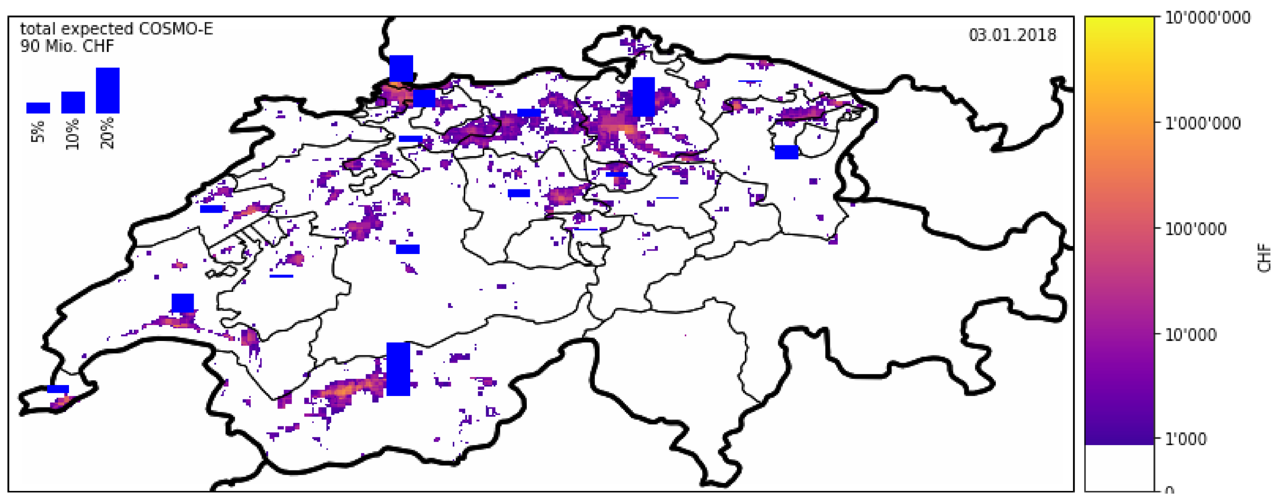
Histograms of the total building damages using the ensemble forecasts of COSMO-E (left) and IFS (right) two days before Burglind hit, one day before and the same day 03.01.2018.

The computed total damage distributions of storm Burglind cover the final reported damage since at least two days in advance. Both damage distributions obtained from the ensemble forecasts COSMO-E and IFS tend to converge towards the reported damage the closer the forecast reference time gets to the event. COSMO-E resulting damages spread over lower values than the reported one mostly due to its underestimation of up to 20 km/h of the maximum wind speeds during the event, see MeteoSwiss report on Burglind[5]. The presumably accuracy reached by IFS is not reflected at local scales, where IFS resolution fails to capture the Swiss orography.

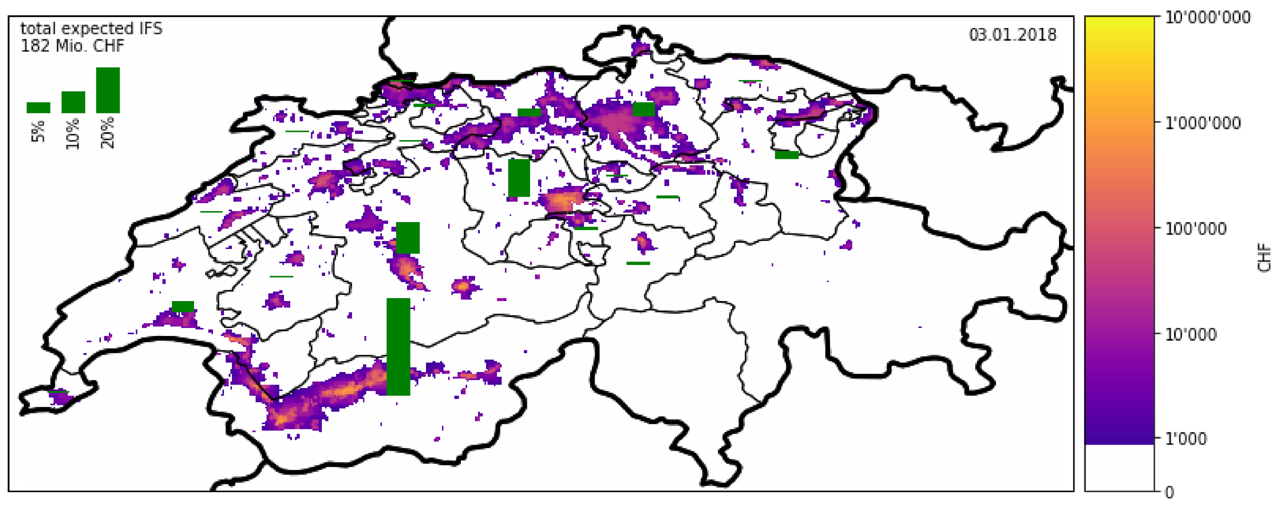
SPATIAL DISTRIBUTION OF DAMAGES



Damages per canton reported and expected from the models COSMO-E and IFS the day Burglind hit. For cantons AI, OW, SZ, UR, GE, VS and TI only their sum of reported damages is known (bottom right).



Expected distributed and cantonal damages from COSMO-E the day Burglind hit.



Expected distributed and cantonal damages from IFS the day Burglind hit.

The largest building damages arose in the cantons of Bern (BE), Luzern (LU), Solothurn (SO), Aargau (AG) and Zürich (ZH). While the expected damages from COSMO-E are generally underestimated, the damages in Basel-Stadt (BS) are overestimated. This can be attributable to the hazard component of the impact model, COSMO-E forecast, as its geographical verification for this event revealed[5]. The lower resolution of the IFS model hinders to resolve the westernmost region of the Rhône valley in the Valais (VS), where only low winds were measured, obtaining an inflated amount of damages for the whole canton. On the other hand, the impact model computed with IFS provides too low expected damages in the northwestern Switzerland encompassing the cantons of Solothurn (SO), Basel-Stadt (BS), Basel-Land (BL) and Aargau (AG).

METHODOLOGICAL IMPROVEMENTS

The presented impact model has succeeded in capturing the overall resulting building damages from storm Burglind in its ensemble range, proving its potential of being operationalised to provide geographically specific impact-based warnings. An improvement of the accuracy in the peek wind gusts estimates of the ensemble weather forecast model during extreme events such as Burglind using e.g. post-processing technics might provide an expected damage closer to the one accounted for. A challenge remains to validate the impact model with the available, crude and not geographically specific damage reports of previous events. Additional data could help to detect improvements for the exposure and vulnerability components as well, and to combine them with more data-intensive technics.

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