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Modelling flood losses of micro-businesses in Ho Chi Minh City, Vietnam

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Supplementary Information

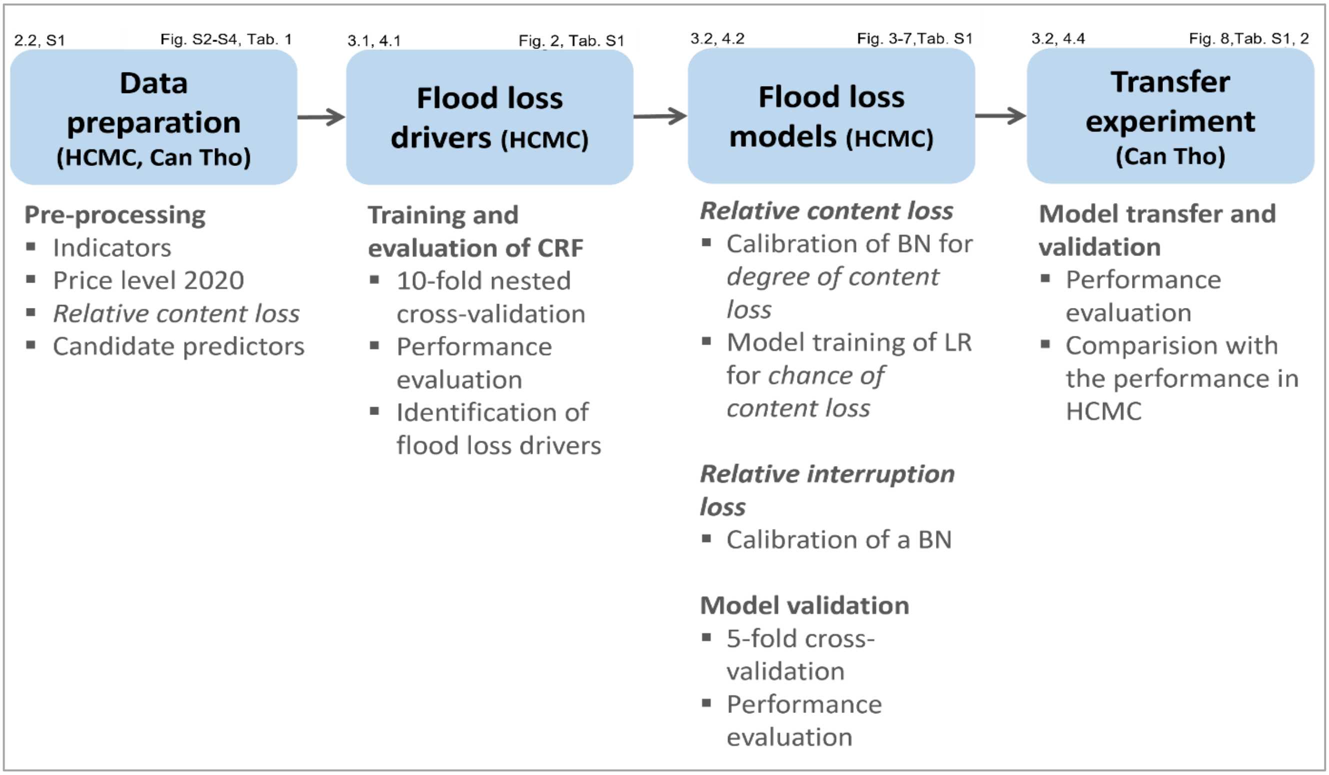

Figure S1: Main steps of the analysis: preparation of the survey datasets, the identification of flood loss drivers, the calibration of the flood loss models and their validation on the HCMC and Can Tho datasets (transfer experiment). Key aspects of the steps are highlighted in light grey. Values in the upper left and right corners of the main steps refer to sections and tables/figures, respectively. Abbreviations: CRF - Conditional Random Forest, LR – probabilistic logistic regression, BN - Bayesian Network.

S1: Pre-processing of the survey data

Monetary variables were reported in both surveys in Vietnamese Dong [VND]. The monetary variables are converted to Euros and, where appropriate, inflation-adjusted to 2020 via a Gross Domestic Product (GDP) price deflator (Oanda, 2024; Trading Economics, 2024). The variables from the HCMC survey that potentially explain flood losses to microbusinesses were further pre-processed to obtain a well-defined set of candidate predictors and response variables (see, Table 1). The response variables include flood loss to business contents (e.g. to furniture, electrical devices, stored products and vehicles) and business interruption losses (e.g. reduced sales and production). The latter was queried in the HCMC survey as economic losses relative to the average revenues of the microbusinesses [%], while the former was reported in terms of monetary values [VND] and thus needed to be transformed to a relative scale, i.e. as a ratio between monetary loss and the value of the business content. The business content values were calculated by assuming that the monetary loss to an entirely commercial-used building equals the value of its damaged business content (FEMA, 2013; Huizinga et al., 2017). Since the approach is rather general and made for larger companies, we improved this approach with a correction factor (0.25) resulting in a weighted relationship between building and content values. However, some interviewees did not report the building value and thus relative content losses were not calculated for these records, resulting in a reduced number of 317 records for relative contents losses. Since business interruption losses were already queried as relative values in the HCMC survey, their number of 361 records remained unchanged. In order to derive the value of the commercially used part of the building (i.e. ground floor), we used field survey data on the number of floors in the microbusinesses or, in the case of missing data, assumed the most common building type (a two-storey building) (Moon et al., 2009).

Binary responses (0 or 1) from the survey corresponding to a specific category were combined to form indicators. For instance, the presence of several types of flood water contamination and implementation of several emergency measures were translated into indicators. Among the ordinal-scaled responses on the implementation of structural and non-structural precautionary measures and flood resilience were also converted to indicators (Sieg et al., 2017; Paprotny et al., 2020; Schoppa et al., 2020).

The indicators for emergency measures and precautionary measures are ratios between implemented measures prior to the flood event (nI) and the number of possibly implemented measures (nP). These ratios are on the interval [0, 1], where 0 assigns to businesses with no implemented measures and 1 to well-prepared businesses who implemented all possible measures prior to the flood event (Schoppa et al., 2020).

The flood resilience indicator is also a ratio but based on ranked variables of five categories. The indicator expresses the perception of the respondent on how well the government, city or the neighbourhood helps the citizens in coping with floods. For each category, the respondent could provide a response on the interval between 0 (strongly disagree) and 5 (strongly agree).

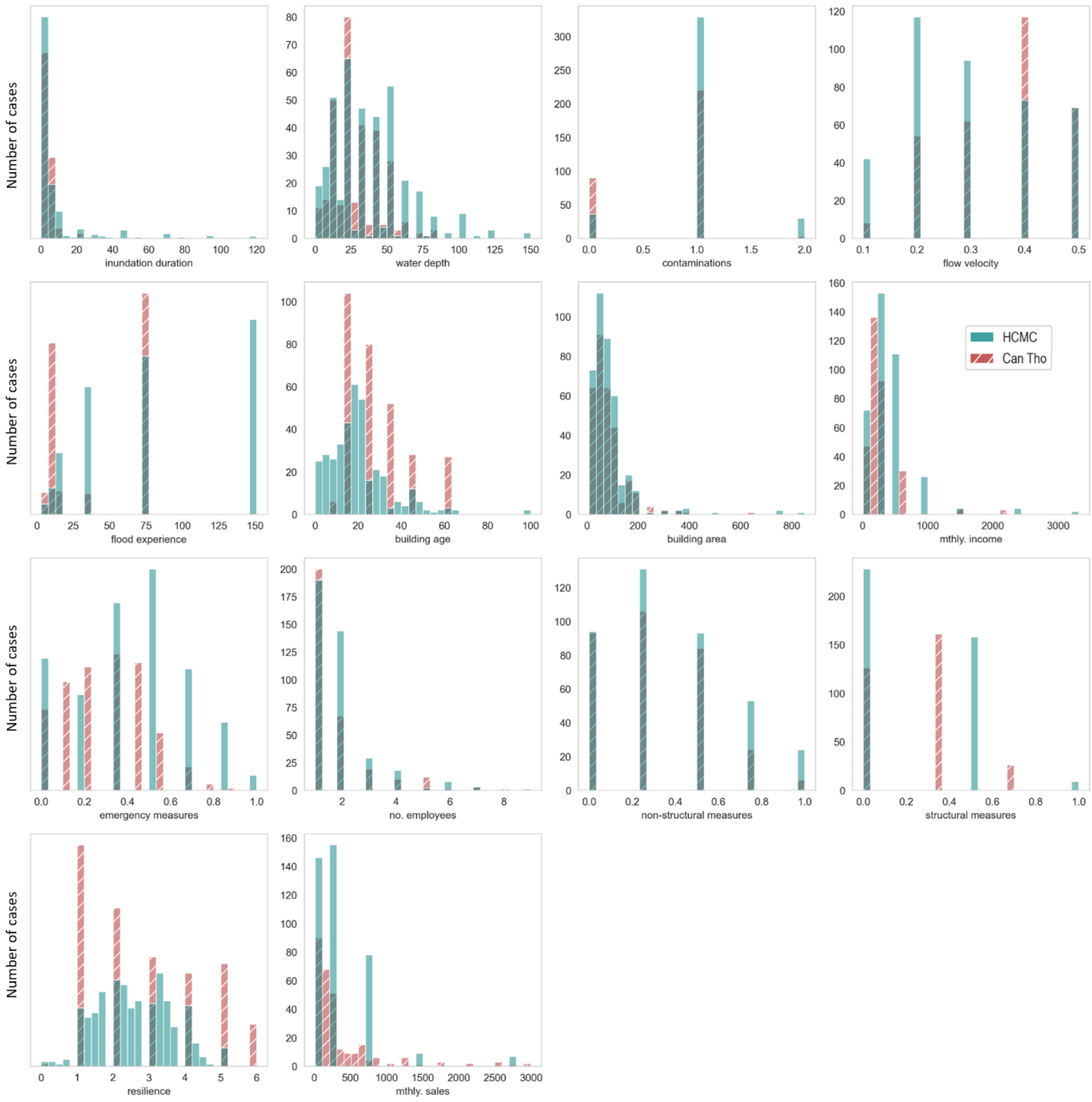

Figure S2: Distribution of potential predictors for HCMC and Can Tho. For a better visualization three to five extreme cases are removed for the variables: inundation duration, building area and monthly sales.

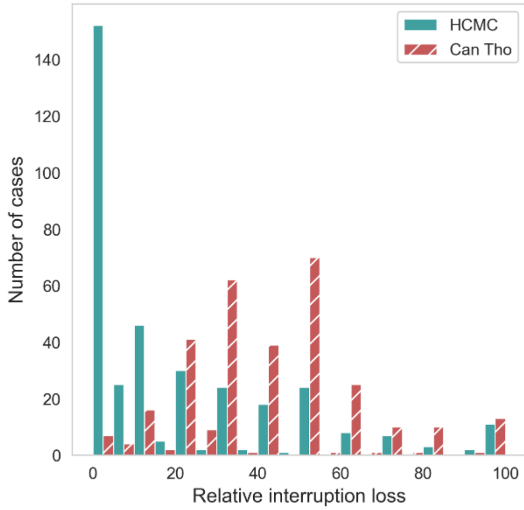

Figure S3: Distribution of reported relative losses due to business interruption during the flood (HCMC) and during the flood month (Can Tho). The first bar on the left side of the HCMC dataset contains cases of zero-losses as well as a large share of cases representing minor losses (<5 % interruption losses).

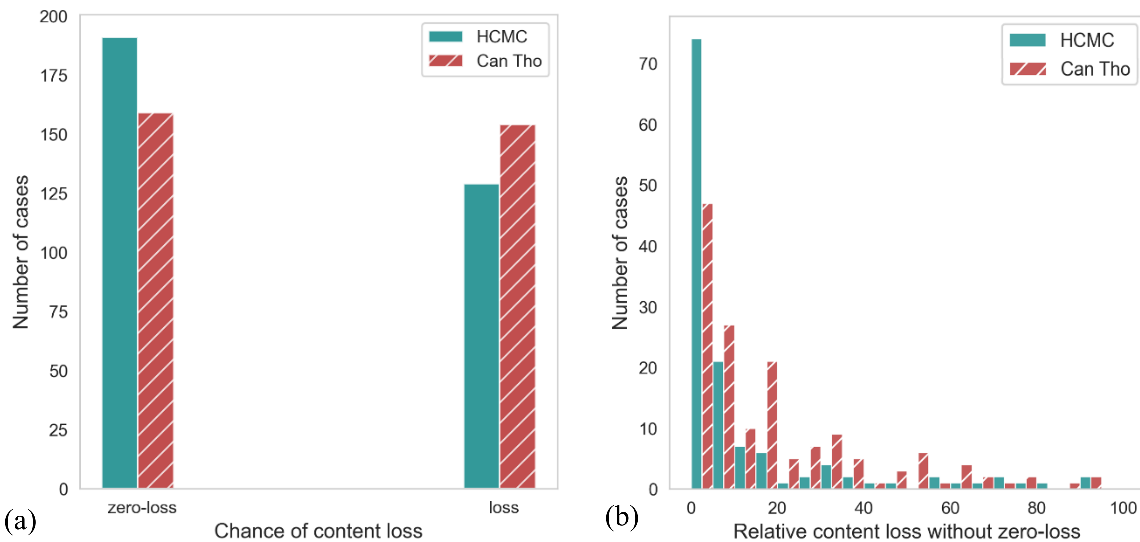

Figure S4: Distribution of reported relative losses to business content. (a) Distribution of zero-loss and loss cases. (b) Distribution of degree of content losses (only loss cases).

Table S1: Performance metrics used in the paper

Performance metric	Equation	Value range
Mean Absolute Error	$MAE(x,y) = \frac{\sum_N^{i=1} \lvert y_i - x_i \rvert}{N}$	[0,∞]
Mean Bias Error	$MBE(x,y) = \frac{\sum_N^{i=1} y_i - x_i}{N}$	[-∞, ∞]
Root Mean Squared Error	$RMSE(x,y) = \sqrt{\frac{\sum_N^{i=1} (y_i - x_i)^2}{N}}$	[0, ∞]
Symmetric Mean Absolute Percentage Error	$SMAPE(x,y) = 100 * \frac{\sum_N^{i=1} \lvert y_i - x_i \rvert}{\sum_N^{i=1} \lvert y_i \rvert + \lvert x_i \rvert}$	[0, 100]

Symbols: x_i is the i-th observation, y_i the i-th prediction, N the sample size.

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