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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "On the occurrence of rainstorm damage based on home insurance and weather data" *by* M. H. Spekkers et al.

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We thank the reviewer for his/her constructive comments and suggestions. Our response:

RC1: *On Section 2.1 Case study description - Have you verified if for the period 2007 - October 2013 there weren't significant changes in population density, type of building construction or with the sewer system that could affect data information?*

AC1: The reviewer is right that changes, such as changes in sewer infrastructure, may have affected claim information. However, we do not think that these changes have

significant effects on present results, for two reasons: First, the study period is relatively short (less than 7 years) compared to rate at which changes (e.g. in population, sewer systems) take place. For instance, around 30 km of sewer is replaced per year in Rotterdam on a total of around 2500 km. Population has increased with around 5 % between the years 2007 and 2013. Second, the changes are likely to affect claims locally (e.g. sewer replacements in specific neighbourhoods), while the results of this study are presented at the city level, e.g. logistic regression coefficients are estimated globally. We would like to make this assumption more explicit in the final paper by adding the following sentence after line 14 on page 5291: "It is assumed that within the study period no changes have been made to the sewer infrastructure and the building portfolio of Rotterdam that have significantly affected results of present paper.".

RC2: *On Section 2.2 Insurance data - I suggest including the Achmea group website.*

AC2: Good suggestion. We will add the following footnote after the first sentence of section 2.2: "Website of Achmea insurance group: http://www.achmea.nl.".

RC3: *On Section 2.2 Insurance data - You explain the data set contains information of only the 6% of the total number of households in Rotterdam. Do you know the market covered by this insurance company in Rotterdam or maybe the total number of insurance policies? I suggest including it for a further comprehension of the results and their level of significance.*

AC3: There is a total number of around 21 000 insurance policies, of which around 6000 relate to building structure insurance and around 15 000 to building content insurance. This means that 5000 risk addresses have both building structure and content insurance available. We will append this information to line 25–26 on page

5291 as follows: “On average, the data set contains information of around 16 000 risk addresses, which is 6 % of the total number of households in Rotterdam. These risk addresses constitute a total number of around 21 000 insurance policies, of which around 6000 insurance policies relate to building structure insurance and around 15 000 to building content insurance.”.

RC4: *On Section 2.2 Insurance data - You explain that the data set contains information of about 16.000 risk addresses. Are these risk addresses uniformly distributed or are located in only some neighborhoods of Rotterdam? This information may be useful for the analysis of water-related damages, especially the ones not produced by heavy rain (exposure, age of buildings, vulnerability areas to water - damages...). Thus, my suggestion is to include a map with a density distribution of claims.*

AC4: Very interesting remark. In fact, we are considering a spatial data analysis in a subsequent paper, which will include factors related to vulnerability, such as building age. This requires the collection of additional data and the application of statistical methods that can deal with spatial structures in data. In this paper we only consider weather variables, because our aim was to investigate weather-related relationships/thresholds for Rotterdam as a whole, not considering any local conditions. We would like to elaborate on the reviewer’s comment a bit more in the section 5 (Conclusions and recommendations) as follows: “It is worthwhile to investigate spatial distributions of water-related claim data in a future study, considering local conditions such as building age and type and percentage of impervious area.”

RC5: *I would like to see the annual distribution of the 3100 water-related claims during the period. It would help to verify no trends on collected data.*

AC5: We agree with the reviewer that such a figure is a useful addition to the final paper. We would, therefore, like to add a new figure to the results, see Figure 1 that is provided in the supplement to this response. At the start of section 3.1, the following sentence will be added: “Figure 1 (upper panel) shows the yearly distribution of precipitation-related (white) and non-precipitation-related claims (grey), for the years 2007–2013. For both classes, there is an increase in the number of claims through the years. The increase in the number of claims is most apparent between 2008 and 2010 for precipitation-related claims and between 2009 and 2012 for non-precipitation-related claims. Possible explanations of these trends are discussed in Section 4.”. We would then like to continue in a new paragraph after line 2 on page 5300: “In Fig. 1 an increasing trend is observed in the number of water-related claims in the period 2007–2013. There are a number of possible explanations for this trend. To start with, the number of policyholders may have increased in time. This could not be verified, because in present study only policyholder data were available for a single snapshot in time. Another explanation may be related to bursts of household water supply pipes, which is the most frequent cause of non-precipitation-related claims. Based on an unpublished report, the insurance company has observed a substantial increase in defects in water supply systems in the recent years, mainly because of incorrectly installed compression fittings. Other explanations that may be worthwhile to investigate are differences in climate variables between years and the effect of 2007–2008 financial crisis on the claiming behaviour of people.”.

RC6: *On Section 2.4 Weather variables - Why the duration of the precipitation (hours for example) was not considered as a relevant variable? Some studies state there’s a relation between damage and storm duration, so it could be an interesting significant predictor.*

AC6: In two related studies, based on similar insurance databases, we found that

rainfall duration has no significant or weak effect on damage. To justify our variable choices, we would like to add the following sentence after line 17 on page 5293 (section 2.4 on weather variables): “Rainfall duration was not considered, because previous studies based on a similar insurance database for the Netherlands show that rainfall duration has no significant or weak effect to rainfall-related damage (Spekkers et al., 2013, 2014).”.

RC7: *On Section 2.6 Discarded data - You have explained that extremely stormy days are classified as storm-related claims, so they are not considered on this study. You have referenced three extremely storms but at last, how many storms have been excluded of this study?*

AC7: The three storm days mentioned in section 2.6 are the only days that have been excluded. To clarify this, we would like to rephrase the last sentence of section 2.6 to: “These three days are excluded from the logistic regression analysis.”.

RC8: *On Section 3 Results - One thing I expected to find in the paper is the number of cases. We have information about the number of claims and of risk addresses, but we don't have an idea of the number of cases involved or the average of claims related to one case. It would be necessary to quantify these values, so I suggest introducing this information.*

AC8: We are not entirely sure if we understood the point by the reviewer correctly. In the case he/she refers to “a case” in the context of logistic regression analysis, we mean the following. In the logistic regression analysis, a case is defined as an unique combination of risk address ($\approx$ 16 000 risk addresses) and day ($\approx$ 2500 days), thus the total number of combinations is 16 000 $\times$ 2500. Each case can either value 0

(no claim) or 1 (a claim) (see also, line 25–26, page 5293). The average number of claims per case is mentioned at line 12 on page 5294, namely 2.67 $\times$ 10^{-5}, based on the number of precipitation-related claims (i.e. 1031) only. To clarify this, we would like to rephrase line 12-13 on page 5293 (section 2.4 on weather variables) to “A set of weather variables was derived for each combination of risk address and day (i.e. a case) to investigate...” and line 25 on page 5293 to “For each case, a unique combination of risk address and day, the outcome can...”.

RC9: *On Section 3.1 Relative occurrence frequencies and costs of claims - I suppose economic costs related to damage cases have been adjusted for inflation, but there is no information about it. It has to be included in this section when you compare damage costs.*

AC9: Good point. We did not adjust costs for inflation. We have ignored the inflation correction, because the study period is relatively short and cumulative inflation is, therefore, relatively small (12%). We would, however, like to take into account the reviewer's suggestion and apply the corrections nonetheless as it gives a more accurate representation of the data. The following will be added to section 2.2: “Every value associated with a year before 2013 was adjusted for inflation according to the correction indices in Table 1.” (for Table 1, see end of this document). An updated figure with claim sizes (Fig. 3 in the discussion paper) is enclosed in the supplement to this response (Fig. 2 in the supplement). The conclusions that can be drawn from the figure are still the same. After applying inflation corrections, the values on line 4 and 6 on page 5296 (and on line 3 and 4 on page 5301) will be EUR 1150–3160 and EUR 680–840 respectively.

RC10: *On Section 3.1 Relative occurrence frequencies and costs of claims - You explain that wall leakages and roofs usually do not involve large water volumes. On*

which information is this based?

AC10: This is based on the information in the communication transcripts. Although the transcripts hardly contain quantitative statements about water volumes, many qualitative statements are made indicating that roof leakages involve small water volumes, such as "only walls are wet" and "floor carpet is still oke". In the case of sewer floods, at the other hand, statements are made such as "requires significant cleaning of entire floor" and "water in basement needed to be pumped away".

RC11: *Season is selected as a significant factor because of snow, hail and problems asso- ciated with leaf fall. Therefore, it would be interesting to have a figure or percentage value about seasonal distribution of the claims.*

AC11: A nice suggestion is made by the reviewer. We would like to take this suggestion into account by adding the following text and figure to section 3.1: "The monthly distribution of precipitation-related claims are given in Fig. 1 (lower panel). Most precipitation-related claims are recorded in July–August and December–January; the December–January claims can partly be explained by the damage due to melting snow. Claims related to sewer flooding mainly occur in June–August.". For the figure, see supplement to this response.

RC12: *On Section 3.2 Effects of rainfall intensity on claim occurrence probability - You have obtained a low threshold for rainfall intensity compared with sewer design. On average, which is the normal rainfall intensity in Rotterdam city? What is the return period for this intensity?*

AC12: It is not entirely clear to us what the reviewer exactly means with "normal" (in

"normal rainfall intensity"). If he/she is interested in the return period of the rainfall events that a Dutch sewer system should be able to cope with then we can say the following: in the 70s, sewers were designed to cope with 60 or 90 $\mathrm{L\,s^{-1}\,ha^{-1}}$ for flat and sloped areas respectively (Koot, 1977). These values correspond to rainfall intensities of 21.6 and 32.4 $\mathrm{mm\,h^{-1}}$. Nowadays, hydrodynamic models are being used to test the hydraulic design of sewers based on design storms with usually a return period of 2 years (Van Mameren and Clemens, 1997; Van Luijtelaar and Rebergen, 1997), which is approximately 20 $\mathrm{mm\,h^{-1}}$. So, to be more precise, we should rephrase line 7–8 on page 5297 as follows: "Dutch sewers are designed to cope with rainfall intensities of 20 $\mathrm{mm\,h^{-1}}$, which is associated with an event return period of approximately 2 years (Van Mameren and Clemens, 1997; Van Luijtelaar and Rebergen, 1997)."

RC13: *On Section 3.2 Effects of rainfall intensity on claim occurrence probability - For this analysis, did you use all of the cases or only those ones related to precipitation? You have also explained some problems with claims dates' not corresponding to the incident day (maybe because vacation period). Have these cases been filtered? How many cases have been analysed in this section?*

AC13: Results in section 3.2 relate to precipitation-related claims only (see line 16, page 5296). To clarify that the second line of section 3.2 ("A further distiction...of Table 2.") is also about precipitation-related claims, we like to start the sentence as follows: "Within the subset of precipitation-related claims, a further distinction...of Table 2.". Moreover, we would like to rewrite the first sentence in the caption of Fig. 4 to "The empirical probability of precipitation-related claim occurrence per day...".

We have mentioned the "holiday bias" as a possible uncertainty in the data; there are, however, no simple ways to validate if a date is correct or not. Thus, we have not filtered out any claims because of this. The insurance company has indicated that number of claims with incorrect dates is probably small. For the question about the number of

cases that have been analysed, we refer to AC8.

Inspired by the reviewer's remark, it would be worthwhile to make the number of claims that have been used to generate Fig. 4 more explicit in the text (line 16–10, page 5296): "In Fig. 4 the empirical probability of precipitation-related claim occurrence per day per risk address, as a function of the rainfall intensity is shown (black dots, based on 1031 claims). Within the subset of precipitation-related claims, a further distinction was made between the occurrence probability of claims caused by failure of systems in the private (grey dots, 876 claims) and the public domain (light grey dots, 89 claims), according to column 5 ("Domain") of Table 2.".

RC14: *On Section 4 Discussion - What is the return period of the events not considered in this study (the extremely stormy days)?*

AC14: The return periods of these events, considering hourly rainfall intensity, are once every year or less.

RC15: *On Section 4 Discussion - page 5300 line 1, there is a typing error "observed when it it raining..."*

AC15: OK. This will be changed in the final paper.

RC16: *On Table 2 - Information about the remark column has to be included.*

AC16: The following sentence will be added to the caption: "In the remark column, "residual group" refers to a group of claims for which exact failure mechanisms could not be derived from communication transcripts.".

References

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Table 1. Inflation adjustment according to the online database of Statistics Netherlands (Statistics Netherlands, 2014). The average inflation per year for the Netherlands is used, based on the consumer price index. Every damage value associated with a year before 2013 was multiplied with a correction index.

Year	Inflation [%]	Correction
2007	1.6	1.12
2008	2.5	1.10
2009	1.2	1.08
2010	1.3	1.07
2011	2.3	1.05
2012	2.5	1.02
2013	2.5	1.00