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Hydrology and Earth System Sciences Discussions

Interactive comment on "A statistical analysis of insurance damage claims related to rainfall extremes" *by* M. H. Spekkers et al.

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We thank the reviewer for her valuable comments on the discussion paper. Our response:

RC1: *The statistical analyses and presentation of the results is well structured. However, the whole paper and particularly the discussion and conclusions of the paper are too much only focused on the statistical analyses. It is difficult for the reader to extract what we can learn from the analyses. Thus, my main concern is the following: relating the fraction of insurance claims with rainfall intensities is not per se a research question. I even doubt that it is particularly interesting for the insurance industry from*

a practical point of few to have a model to predict of e.g. 20% or 50% of their clients in a certain district will ask for compensation at a particular day.

AC1: This reviewer's comment addresses a similar issue as stated by Van Dyck (in his RC4). The results do certainly have some practical relevance for insurers and others. We would like to add the following paragraph to the discussion: "The results of this study is of practical relevance for insurers, water managers and meteorologists. Some insurers have indicated that the staffing of their call centres (that receive the claims) during extreme events is an issue, and that a better knowledge of what events are likely to cause considerable calls (tens of times more than on a regular day) can be helpful to adjust the capacity of their call centres. It can also be relevant for insurers when reconsidering their policy conditions. The current 'rainfall clause' that is being used (see section 2.2) has some flaws. The rainfall intensities, for example, that are mentioned in this clause are not related to capacities of urban drainage systems. Dutch urban drainage systems are designed to cope with 21.6 mm/h; the '40 mm in 24 h' criteria, for example, should ideally not lead to any flooding. The results of this study show that short-duration intense rainfall already result in a significant number of claims. Another interesting application is the development or validation of weather alarms, which are usually based on some meteorological thresholds. Climate researchers may use the model to extrapolate probabilities of rainfall damage given some projected change in rainfall extremes."

RC2: *A model to predict the amount of pluvial flood damage would of course be very interesting for risk analyses, but the paper does not say anything about the amount of damage, and it remains unclear, if the development of a pluvial flood damage estimation model would be possible on basis of the available data.*

AC2: It is good point by the reviewer to consider the extent to which the available

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data can be used for pluvial flood damage models. We will address this point in the discussion section as follows: “The extent to which the available insurance data can be used for pluvial flood damage models is limited for two main reasons. First, it is hard to distinguish those claims that are related to pluvial floods from those claims related to other failure mechanisms (e.g. leakages of roofs). Insurers use different definitions for pluvial flooding and different systems to categorize claims. A better and more systematic documentation of claim data could overcome this problem. Second, addresses are available at the level of 4-position districts (i.e. neighbourhoods), and therefore it is impossible to relate claims to attributes of individual households, such as the level of precaution, basement use and door threshold level. Simplified damage assessment may be possible at the level of neighbourhoods, when taking into account district-specific properties.” See also our response to RC1 by Arnbjerg-Nielsen.

RC3: *Nonetheless, the paper needs more focus on a clear research question and more related interpretation of the results. Thus, I suggest focusing on a question like “From which maximum rainfall intensity onwards a rainfall event becomes a ‘damaging rainfall event’.” Single sentences in the paper already point into this direction, e.g. “Most observations without damage (Y = 0) are associated with low-intensity rainfall, e.g. 99% of the observations without damage are below 6.9mm in 10 min” (page 11625 line 10-11) or “The need to reduce Type 1 and Type 2 errors can be different for different stakeholders. An example from the water manager’s perspective: a decision to open or not to open a water storage facility may lead to unpreparedness in case of a Type 1 error or unnecessary costs in case of a Type 2 error” (page 11627, lines 19-22). However, to answer this suggested research question more focus on rainfall events and the identification of thresholds would be necessary.*

AC3: The reviewer poses an interesting question, which is not explicitly stated in the paper as such, but is partly addressed in Table 4 and lines 14-18 on page

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11626. The rainfall threshold is here defined as the rainfall intensity for which probability of rainfall damage equals 0.5; a 'damaging rainfall event' may be defined as those events with rainfall intensity larger than the rainfall threshold. Note that this 'cutoff value' ($\theta = 0.5$) depend on whether a potential decision-maker has a more risk-seeking or risk-averse attitude; see also our response to RC7 by Arnbjerg-Nielsen.

RC4: *Page 11618, line 13: Since the study of Ririassa and Hoen (2010) might not be available to everyone, more detail about its results and about the differences to the presented study should be given.*

AC4: Good suggestion. Although the report is available online, it is unfortunately in Dutch. We will add the following lines to the introduction, page 11618, line 11: "The analysis built on earlier work by the Dutch Association of Insurers, where relationships between rainfall and claim data were studied at a regional scale (Ririassa and Hoen, 2010). Using simple linear regression, they found significant relationships between the total amount of damage in a province (roughly 2500–3500 km^2 in size) and hourly rainfall data (one or two rain gauges per province), but the explained variance was low (4% for content and 12% for property). It can be argued that given the size of a province and the limited number of rain gauges used, the model does not account for variation in damage caused by local rainfall, whilst local convective rainfall is probably an important contributor to damage. The present study considers rainfall at scales most closely related to the functioning of urban drainage systems. The aim of the present study was to investigate whether the probability of rainfall damage is associated with the intensity of rainfall. Separate relationships were analysed between rainfall data and property damage data as well as content damage data, through statistical analysis."

RC5: *Page 11619, lines 2-5: These sentences are not necessary and basically repeat*

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what has been written in the paragraph before.

AC5: We will remove these lines in the final paper.

RC6: *Page 11620, line 6: What is with other flood types besides pluvial flooding; e.g. inundation due to riverine flooding, due to high groundwater levels or due to coastal flooding which would also not be related to rainfall intensities in the same district. Are these flood type impossible in the Netherlands due to high flood protection?*

AC6: We would like clarify this a bit more in the final paper. After the sentence "Damage due to pluvial floods should be directly and solely related to local extreme rainfall for a claim to be accepted." (page 11620, line 13) we would like to add: "Flooding from rivers, sea or groundwater is not commonly insured in the Netherlands and therefore if pluvial flooding coincides with other flood types, the damage is not insured.". Floods from rivers and sea are, however, rare in the Netherlands because of the high protection standards.

RC7: *Page 11620, lines 20 and following: Does the data contain information about the total asset values of the building or contents (total insured value)?*

AC7: Yes; however, asset values of buildings and content are stored in separate databases and it is unfortunately not possible to link both databases. Therefore we cannot determine the total insured value for a particular household. We would like to add the following to page 11620, line 24. "The databases with policy holder information related to content and property are separate databases and it is impossible to link them to each other. Therefore, one cannot link content and property claims to a single address." Note that we will also add a table with variables that are included in the

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the databases, but are not used in the present study (e.g. building and content asset value). For that, see our response to RC2 by Arnbjerg-Nielsen.

RC8: *Page 11621, line 15: Did the districts change over the years? If yes, how did you deal with it?*

AC8: We have used a 4-position districts map from 2011. We didn't have maps or a list of changes since 2003. The districts are used for postal services, and as far as has been documented, there have not been any drastic changes in the coding since 1978. When the system was built, they intentionally didn't assigned every 4-position code, to be able to easily add newly build neighbourhoods without changing the existing codes.

RC9: *Chapter 2.4: Could changes of insurance coverage or contract conditions over the years influence/disturb the identification of "dry claims" versus "wet claims"? What means "high claim numbers"?*

AC9: As far as we know from interview with insurance experts, the most notable change in the policy conditions related to water damage took place in 2000, which affected almost all property and content insurances in the Netherlands. Since that moment, property and content insurances have similar conditions in terms of coverage. We therefore do not expect a trend break within the study period. On page 11622, line 10 we would like to change "high claim numbers are" into "a high number of claims in a rain gauge region on a particular day is".

RC10: *Page 11624, line 19: "maximum rainfall intensity is a significant predictor for damage" Might be misleading, since not amount of damage is estimated but the fraction of insurance claims.*

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AC10: Good point. We propose to rephrase the sentence to: "maximum rainfall intensity is a significant predictor for the probability of rainfall damage."

RC11: *Page 11625, lines 23-25: "There is a slight improvement in the model predictability if rainfall intensity is based on longer time windows, with an 'optimum' between two and four hours." What does this tell us? What can be concluded from this finding?*

AC11: A very interesting point. It could be that these time scales are associated with time scales of some underlying damage mechanism(s); however, what these mechanisms are remain a question. We would like to add the following paragraph to the discussion section: "It would be interesting, for example, to be able to better distinguish between those claims related to flooding from sewer systems and those related to leakages of roofs, and thus be able to link time scales of rainfall to capacities and response times or urban drainage systems." To get such detailed claim data remains a challenge.

RC12: *Page 11626, lines 4-5: "The results indicate that higher damage observations are more likely to be associated with rainfall data than lower damage observations." Isn't this trivial, since the data has been selected according to this criterion (chaper 2.4)?*

AC12: The sentence is related to the one before, but may be confusing because of the use of the term 'higher damage observations'. We like to rephrase line 2-5 on page 11626 as follows: "Lowering the significance level α, and hence selecting observations that are related to a larger number of claims, improves the predictability by high rainfall intensities. In other words, the results indicate that observations related to a larger

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number of claims are more likely to be associated with rainfall data than observations related to a smaller number of claims."

RC13: *Page 11627, lines 8-10: It is a quite important discussion what other factors are influencing the fraction of insurance claims. More effort to describe and discuss other influencing parameters should be undertaken. For instance, what is with the capacity of the sewer systems, topography, emergency or precautionary measures? What is with insurance contract conditions like deductibles?*

AC13: This point is also addressed by Arnbjerg-Nielsen (in his RC6). We would like to add the following paragraph in the discussion section: "A considerable fraction of the variance is left unexplained, which emphasizes the need to study other explanatory variables. There are a few aspects that need to be considered when taking other explanatory factors into account: 1) the explanatory variable should be available and parameterized at the level of 4-position districts, as this is the scale at which insurance data is available, 2) data should be available nationwide if the analysis is performed on the whole insurance database and 3) since additional data come from different sources, different levels of data quality need to be considered. Explanatory factors that are worthwhile to investigate in a future study are topographical properties, urban drainage system properties (e.g. drainage capacity, age of infrastructure, percentage of surface water), level of urbanization, socio-economic indices (e.g. income of households, property value), district properties (e.g. percentages of low-rise and high-rise buildings, percentage paved surface)."

RC14: *Page 11628, lines 5-6: Since the analyses are focused on the fraction of insurance claims I wonder why you separate building and contents claims?*

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AC14: Unfortunately we cannot link building and content claims to a single address, see also AC7. Moreover, there are more content insurances than property insurances as content insurances are related to both tenants and homeowners, whereas property insurances are related to homeowners only (see page 11620, line 23).

RC15: *Page 11628, lines 9-11: My impression is that better damage data would be by far more important in comparison with better rainfall data. Maybe a scientifically based collection of damage data would be necessary to gain more knowledge about the damaging processes during pluvial flooding. It should be discussed for what analyses insurance data are suitable and where their limitations are.*

AC15: There is certainly much to gain by improving damage databases, see also AC2 on some of the limitations of the used insurance database. The rainfall data that has been used in this study did limit the analysis in that way that we have only used a small subset of the insurance data (the claims close to a rain gauge). Large fraction of the damage database was therefore not used. We are exploring now the use of weather radar data, which is available for the Netherlands since 1998, so we can potentially use the entire insurance database. We are currently discussing with one the insurance companies ways to improve their databases and to be able to make more detailed analysis in the future.

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