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ABSTRACT
The mixed results in Pielke (2020) for natural disaster loss normalisation studies are due to methodological differences. Flaws exist in commonly used normalisation approaches that assume unitary elasticities between exposure indicators and losses. We refute Pielke's arguments that statistical studies estimating these relationships are biased. We conclude with an agenda for future research.

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Pielke (2020) offers an overview of results of 54 studies that normalised natural disaster losses to remove the influence of societal change from loss trends and to examine if a trend remains in the normalised loss records. The absence of a remaining trend is interpreted as finding 'little evidence to support claims that any part of the overall increase in global economic losses documented on climate time scales can be attributed to human-caused changes in climate' (Pielke, 2020). However, the results of the reviewed studies are mixed and appear to be driven by important methodological differences that warrant closer inspection. We discuss fundamental shortcomings in this literature that hamper drawing firm conclusions about the drivers of natural disaster losses. We hope that this serves as an agenda for future research that inspires other researchers to join this field that is currently dominated by a small group of authors.

The typical loss normalisation adjusts natural disaster losses by scaling historical losses with observed growth in wealth and population, as indicators of exposure to natural hazards (Pielke & Landsea, 1998). Wealth is often approximated with GDP or the value of the building stock. This approach assumes constant, unitary elasticities between exposure and natural disaster losses. This is equivalent to a regression that imposes unitary slopes. This does not hold if, for example growth in exposure mainly occurs in high risk areas, such as low-lying floodplains, or newer properties are more vulnerable

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to disaster damage. Alternatively, greater wealth may imply a higher ability or willingness to pay for natural disaster risk reduction measures. Vulnerability is rarely included directly in normalisation studies, due to lacking data, instead its effect on losses is captured by wealth that normalisation studies also use as proxy for exposure. There are many reasons why the assumption of unitary elasticities does not hold. There is also no reason why these relationships should be constant over time, like the standard normalisation approach assumes even if applied to time horizons that exceed a century.

Fortunately, there are no reasons to impose a relationship between exposure indicators and natural disaster losses. Regression techniques can estimate these relationships. Loss normalisation can be based on estimated relationships, instead of assumed ones. Estrada et al. (2015) do this using the same database of U.S. hurricane losses that Pielke et al. (2008) used. Estrada et al. (2015) find that elasticities between exposure indicators and losses are not equal to one, and that a trend in losses remains if the normalisation is based on empirically estimated elasticities. Pielke et al. (2008) instead find no trend based on the standard normalisation approach.

Figure 1 shows that the assumption of unitary elasticities is violated in many studies. Eight studies published 52 estimates of the income elasticity of natural disaster losses.[1] The weighted average is 0.32 with a standard error of 0.03; 92% of estimates is smaller than 1, the assumption in the standard normalisation approach in which losses increase proportionally with wealth as indicator of exposure. This casts doubt on both the validity of many of the studies reviewed by Pielke (2020) that adopt the standard normalisation approach, and on the main conclusion of the review that the studies showed that climate change has not contributed to trends in natural disaster losses.

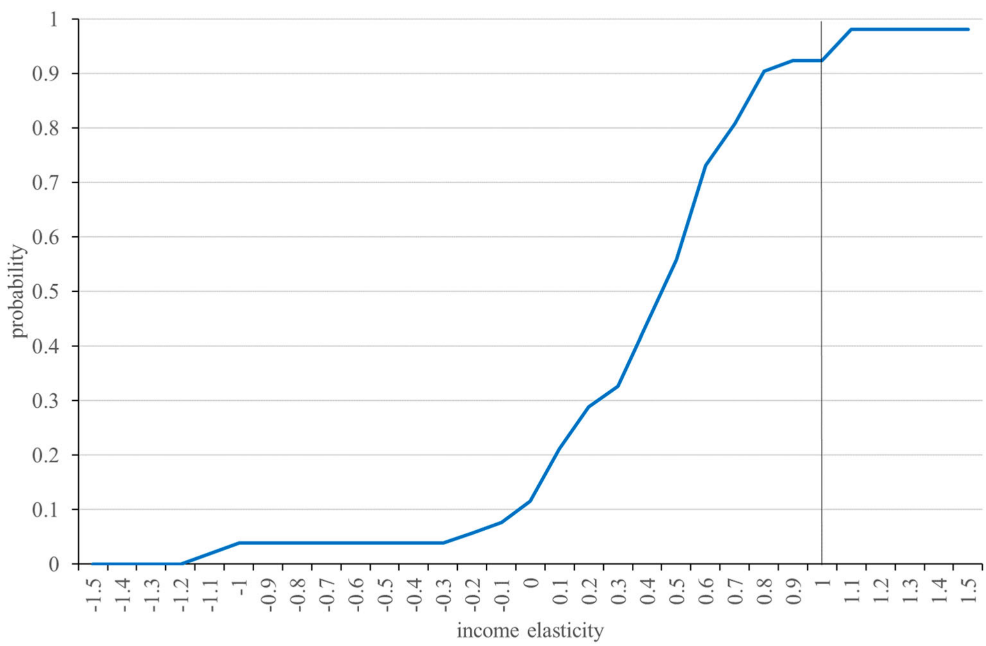

Figure 1. Cumulative distribution function of 52 published estimates of the income elasticity of natural disaster losses. Source: After Tol (2020).

Pielke (2020) dismisses Estrada et al. (2015) and two other statistical studies that contradict his results. He argues these findings are biased because they result in a lower point estimate than AIR calculated for the recurrence of the 1926 Great Miami Hurricane in 2017. This argument is not convincing. First, the purpose of the regression models is to find a good fit to all observations. The validity of a regression approach cannot be judged by one observation, or a comparison to an event study, like AIRs. Second, Pielke uses Martinez (2020) to support the AIR estimate. Martinez uses the standard normalisation approach with unitary elasticities.[2] This makes the argument tautological: Studies that assume unitary elasticities confirm studies that assume unitary elasticities. Pielke agrees with studies that agree with Pielke. Pielke (2020) missed the opportunity to discuss how methodological choices drive mixed results in the literature from which lessons can be drawn for future research.

We propose the following research agenda. Because natural disaster impacts are local, normalisation studies should use local indicators of exposure and vulnerability, instead of commonly used aggregate indicators that have been shown to bias results (see Estrada et al., 2015, Supplementary Information). A fundamental shortcoming of the current literature is that changes in vulnerability are often not, or incompletely, accounted for due to lacking data. Future research could improve the representation of vulnerability; otherwise firm conclusions on the existence of a climate signal in losses cannot be drawn. This also implies that statements in Pielke (2020) that climate data serves as an independent check of loss normalisations results do not hold, since there is no reason why normalised loss trends that incompletely account for societal change should match climate trends. Climate factors influencing storm losses go well beyond their category and quantity. For example, sea level rise increases the inundation extent and depth during a storm surge. Finally, relationships between exposure and vulnerability should be estimated with statistical approaches, instead of assuming some relationships. Future research could estimate these relationships for other contexts and natural hazards than Estrada et al. (2015), to examine if conclusions from normalisation studies that assume these relationships should be revisited.

Notes

1. Most studies reviewed in Tol (2020) show that the income elasticity is not constant.
2. Pielke (2020) also cites Bouwer and Botzen (2011) who illustrate that loss normalization studies using aggregate instead of local exposure indicators may be biased.

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