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Forecasting the Risk of Extreme Massacres in Syria

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Abstract: An abundance of large data sets and improved estimation methods have enabled conflict researchers to estimate the risk of war or terrorist incidents quite precisely. However, as in the case of the prediction of particularly violent earthquakes, forecasting extremely bloody events in continuing conflicts has been difficult until now. This article reports how power laws can be used to predict extreme massacres *ex post* and *ex ante*. The power-law distribution that we use is based on the observation that standard probability distributions like the normal distribution typically underestimate the risk of such escalations. Using fatality data until the end of February 2013, we calculate the probability of at least one single event with 250 or more dead civilians at 80% (59%–94%) and between March and May 2013 of up to 48%. We discuss the ethical and practical implications of these findings and argue that the forecasts could provide a transparent risk assessment tool to decision makers.

Keywords: One-sided violence – civil war – power-law distribution – conflict prediction – early warning – Syria

1. Introduction[1]

The Syrian civil war has aroused a wide variety of fears. From the very beginning of this conflict these concerns especially included speculation about the possible use of weapons of mass destruction and the occurrence of extreme massacres. When

1 The article was originally published in May 2013 in the *Zeitschrift für Friedens- und Konfliktforschung* (http://www.zefko.nomos.de/fileadmin/zefko/doc/Aufsatz_ZeFKo_13_01.pdf) and has been translated and slightly adapted by the authors for this publication. The data used in the original as well as this analysis can be found on the data replication page of the second author (http://www.polver.uni-konstanz.de/gschneider/arbeitspapiere/replikationsdaten/). Gerald Schneider has received financial support for this research through the *German Peace Science Foundation*. The original idea for this article has been presented at the workshop "The Quality of Measurement" at the Technical University Dresden in September 2012. This presentation and colloquia at the Universities of Mannheim and Konstanz as well as the Peace Research Institute Frankfurt further strengthened the original article as well as this adaptation. We would like to thank Dominic Nyhuis for his support on the data extraction, the two reviewers for helpful comments, Christoph Weller, Wolf-Dieter Eberwein, and Antoinette Groom for their help and their efficient management of the publication process.

the fighting in Aleppo, the second largest city, intensified in the summer of 2012, British Foreign Secretary Hague[2] warned of a "potential massacre": "This utterly unacceptable escalation of the conflict could lead to a devastating loss of civilian life and a humanitarian disaster." UN Special Envoy Brahimi similarly alerted the world community in early 2013 that the civil war could claim more than 100,000 civilian casualties by the end of the year should no political solution be found.[3]

Sadly, as we know, these prophecies have become true in the meantime. The Ghouta chemical attack of August 21, 2013, left several hundred people dead. Four months later, the UN confirmed in an official report that weapons of mass destruction had been used in this incident as well as in four other incidents.[4] According to the Syrian Observatory for Human Rights, more than 120,000 people had been killed in the war by December 2013.[5]

This article reports on the attempt, in February 2013, to forecast whether the conflict would escalate further and whether the war-torn country would again fall victim to extreme massacres with several hundred people killed in the period from March to May, 2013.[6] The central technical innovation of our article is the usage of power laws to predict massacres. A pioneer of peace and conflict studies, Lewis F. Richardson[7], was the first researcher to establish that the number of fatalities in conflicts follows a power-law distribution. This means that extremely violent conflicts like the two World Wars of the 20th century are rare, but occur much more frequently than one would expect on the basis of the normal distribution or similar statistical distributions.

Events like those occurring during the Syrian civil war follow a power law if the probability of occurrence is inversely proportional to the intensity of the individual acts of violence. Hence, conflict dynamics exhibit similar statistical characteristics as other processes for which Taleb[8] has introduced the metaphor of 'black swans.' The financial industry has, in his opinion, systematically underestimated the risk of stock market crashes and similar events because traders have based their models on the wrong distributional assumptions.

On this statistical basis we investigate the civil war in Syria, which continued to rage at the time of our analysis at the end of February 28, 2013, to see whether the distribution in the intensity of violence follows a power law and whether information about the conflict can be used for the development of meaningful prediction for political practitioners. Our analysis shows that the violent acts within the Levantine conflict do indeed follow a power-law distribution. Based on the method of Clauset

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2 BBC, "UK government in Aleppo ‚massacre' warning", *BBC News* (July 2012), available: http://www.bbc.co.uk/news/uk-politics-19019658 (accessed 3 February 2014).

3 Nick Cumming-Bruce, "More than 60,000 Have Died in Syrian Conflict, U.N. Says", *New York Times* (January 2013), available: http://www.nytimes.com/2013/01/03/world/middleeast/syria-60000-united-nations.html?_r=0 (accessed 3 February 2014).

4 United Nations Mission to Investigate Allegations of the Use of Chemical Weapons in the Syrian Arab Republic, "Final Report", *United Nations* (December 2013), available: https://unoda-web.s3.amazonaws.com/wp-content/uploads/2013/12/report.pdf, 30/12/2013 (accessed 3 February 2014)

5 Anne Barnard, "Dozens Are Killed in Syrian Violence, Even Amid Preparations for Peace Talks", *New York Times* (December 2013), available: http://www.nytimes.com/2013/12/23/world/middleeast/violence-across-syria-leaves-dozens-dead.html (accessed 3 February 2014).

6 Note that the Ghouta gas attack is therefore not included in our forecasting window.

7 Lewis F. Richardson, 'Variation of the Frequency of Fatal Quarrels with Magnitude', *Journal of the American Statistical Association*, Vol. 43, No. 244 (1948), pp. 523–546.

8 Nassim Nicholas Taleb, *The Black Swan The Impact of the Highly Improbable* (New York: Random House, 2010).

and Woodard[9], we estimate that there was a 11% to 48% risk that at least one massacre with more than 250 killed people would happen in one of the 14 Syrian governorates in the period from March to May, 2013.

Our article ends with a plea in favour of systematic conflict forecasts. Systematic predictions and the establishment of sound early warning schemes are necessary tools for crisis decision-making if the key governments were not able to prevent the crisis from breaking out in the first place. To this end, we compare our approach with other methods used for the forecasting of violent conflicts. We also discuss how power laws can be used as prediction tools, introduce our data sources and conclude with a presentation of our *ex post* and *ex ante* predictions and some general remarks.

2. Predicting political violence: Structural versus procedural approaches

The literature on conflict forecasts differentiates between at least four types of forecast.[10] First, media and government agencies often rely on the predictions, sometimes precise, sometimes oracular, of experts who are considered especially knowledgeable on particular countries, regions or actors. The qualitative predictions these specialists provide have undeniable advantages such as the ability to derive predictions that take the context of the particular case into account. Moreover, such conjectures easily reach a wide audience as they are usually not accompanied by an elaborate technical discussion. Qualitative predictions of individual experts have, however, the disadvantage that they cannot be replicated and that the accuracy often remains unsatisfactory, as Kahneman[11] and Tetlock[12] amply show. Experts are especially biased in the analysis of continuing conflicts. Yet, as the audience often shares the ideology of the specialists, inaccurate forecasts do not necessarily lead to a loss of reputation. The variance of the forecasts grows with the ideological diversity of the experts consulted. It is therefore not surprising that an evaluation of the predictive accuracy of experts (newspaper commentators) and quasi-experts (financial market traders) establishes that the second group predicts more precisely the fate of ceasefires of various Middle Eastern conflicts. This superiority is not the least a consequence of the financial losses that inaccurate forecasts provide.[13]

A second approach to conflict prediction resorts to game-theoretic models of varying complexity.[14] This approach takes expert information on the strength, the strategies, and interests of the actors involved into account, but does not include the speculations of these conflict specialists on possible conflict results. While this ap-

9 Aaron Clauset and Ryan Woodard, 'Estimating the Historical and Future Probabilities of Large Terrorist Events', *The Annals of Applied Statistics*, Vol. 7, No. 4 (2013), pp. 1838–1865.

10 Gerald Schneider, Nils Petter Gleditsch, Sabine C. Carey, 'Forecasting in International Relations: One Quest, three Approaches' *Conflict Management and Peace Science*, Vol. 28, No. 1 (2011), pp. 5–14.

11 Daniel Kahneman, *Thinking Fast and Slow* (New York: Macmillan, 2011).

12 Philip E. Tetlock, *Expert Political Judgment* (Princeton: Princeton University Press, 2005).

13 Naomi Bosler and Gerald Schneider, *The Oracle or the Crowd? Experts versus the Stock Market in Forecasting Ceasefire Success in the Levant'*, Konstanz (2012), unpublished manuscript.

14 Bruce Bueno de Mesquita, *Predicting Politics* (Ohio: Ohio State University Press, 2002); Bruce Bueno de Mesquita, 'A New Model for Predicting Policy Choices: Preliminary Tests', *Conflict Management and Peace Science*, Vol. 28, No. 1 (2011), pp. 64–84.

proach has found various applications especially in the analysis of EU decision making[15], Bueno de Mesquita has chiefly employed it in security studies as, for instance, in an examination of the potential for conflict resolution in the Middle East.[16] In our view it is, however, slightly problematic that this pioneer of political forecasting has not published the algorithms on which his predictions are based, which precludes their objective evaluation.

The third approach to conflict prediction is much more transparent. It attempts to forecast conflict in a country or region through the usage of structural attributes of their units of analysis. Such comparisons have been used in the analysis of interstate war. For example, Ward *et al.*[17] demonstrate that the Democratic Peace theory is able to predict the occurrence of peace in country dyads, but not the onset of war. Technically, this means that liberal theory is able to explain the event which is of lesser interest, peace, but that it cannot be employed, equally successfully, to predict the complementary event, which is conflict, at the same time. Forecasts of civil conflict, conversely, are significantly more accurate. Extending the research of Fearon and Laitin[18], Rost *et al.*[19], for instance, also have predicted the onset of several internal wars accurately.[20]

Structural forecasts share the basic features of the assessments of seismologists that a particular region carries a higher risk of experiencing earthquakes than another one. As structural data are often only available on the yearly level of analysis, we can use this approach to forecast *ex ante* the risk of political violence for a year not covered by the data set. Such predictions can, however, not clarify why some escalations processes in similarly risky countries end in large-scale violence, while others do not. What we therefore need is a process-based forecast for a particular state or region to assess dynamics of the conflict and to deduce predictions about the future development of violence from this basis.

The subsequent analysis of the conflict dynamics in Syria falls into the fourth category of conflict predictions. Methodologically, this type of forecast has, in recent years, resorted to temporarily and spatially disaggregated event data. The appearance of 'big data' has revolutionised the possibilities to analyse conflict dynamics. In this context researchers use advanced statistical techniques and exploit new information sources such as social media.[21] Ruhe[22], for example, attempts to forecast

15 Gerald Schneider, Daniel Finke, Stefanie Bailer, 'Bargaining Power in the European Union', *Political Studies*, Vol. 58, No. 1 (2010), pp. 85–103; Robert Thomson, Frans N. Stokman, Christopher H. Achen, Thomas König, *The European Union Decides* (Cambridge: Cambridge University Press, 2006).

16 Bruce Bueno de Mesquita, 'Multilateral Negotiations: A Spatial Analysis of the Arab-Israeli Dispute', *International Organization*, Vol. 44, No. 3 (1990), pp. 317–340.

17 Michael D. Ward, Randolph M. Siverson, Xun Cao, 'Disputes, Democracies, and Dependencies: A Re-examination of the Kantian Peace', *American Journal of Political Science*, Vol. 51, No. 3 (2007), pp. 583–601

18 James D. Fearon, David D. Laitin, 'Ethnicity, Insurgency, and Civil War', *American Political Science Review*, Vol. 97, No. 1 (2003), pp. 75–90.

19 Nicolas Rost, Gerald Schneider, Johannes Kleibl, 'A Global Risk Assessment Model for Civil Wars', *Social Science Research*, Vol. 38, No. 4 (2009), pp. 921–933.

20 See also Jack A. Goldstone, Robert H. Bates, David L. Epstein, Ted Robert Gurr, Michael B. Lustik, Monty G. Marshall, Jay Ulfelder, Mark Woodward, 'A Global Model for Forecasting Political Instability', *American Journal of Political Science*, Vol. 54, No. 1 (2010), pp. 190–208.

21 See Thomas Zeitzoff, 'Using Social Media to Measure Conflict Dynamics', *Journal of Conflict Resolution*, Vol. 55, No. 6 (2011), pp. 938–969.

22 Constantin Ruhe, 'Predicting Atrocities. Statistically Modeling Violence against Civilians During Civil War', *NEPS Working Paper*, 7/2012.

switches from more to less escalated conflict phases and vice versa. What is missing, however, is a forecast of the death toll of particularly violent events.

In what follows, we intend to close this gap with a micro-level analysis of the dynamics of one-sided political violence in Syria.[23] As indicated, we will employ in our forecasts of civilian victimisation in the Syrian civil war the insights of Richardson and his successors that power laws apply to the intensity of violence across conflicts.

3. Using power laws as a tool for procedural conflict forecasts

There are many natural and social phenomena that follow a power law. For example, phenomena that are suspected of following such a distribution – sometimes even wrongly – include the magnitudes of earthquakes, the diameters of moon craters, the intensities of solar flares, the size of forest fires, or the number of people affected by electricity blackouts.[24] Based on this insight, scholars have attempted to follow the early work of Richardson[25] and to use the unique characteristics of power-law distributions to analyse the severity of violence across conflicts.[26]

Power-law distributions possess two principal features that are of particular interest for scholars when researching the intensities of armed conflict. They belong to the family of heavy-tailed probability distributions. In contrast to conventional distributions like the normal distribution, power laws have more mass in their tail. Unlike the normal distribution under which extremely violent events are almost impossible to occur, power-law distributions attach, even to genocidal massacres, substantial probabilities that they might occur.[27]

Heavy tails are, however, not an exclusive feature of power-law distributions. There is a variety of probability distributions that allocate higher probabilities to events of extreme magnitude than the normal distribution does. The unique feature of power laws is their scale invariance. Scale invariance means that the probability of occurrence of every event, like a massacre, is inversely proportional to its magnitude or intensity. If violence in a given conflict follows a power law, its probability of occurrence is defined by

$$Pr(x) \propto x^{-\alpha} \text{ , for } x \geq x_{min} \quad (1)$$

23 See Kristine Eck and Lisa Hultman, 'One-Sided Violence against Civilians in War: Insights form New Fatality Data', *Journal of Peace Research*, Vol. 44, No. 2 (2007), pp. 233–246; Gerald Schneider and Margit Bussmann, 'Accounting for the Dynamics of One-Sided Violence: Introducing KOSVED', *Journal of Peace Research*, Vol. 50, No. 5 (2013), pp. 635–644.

24 Aaron Clauset, Cosma Rohilla Shalizi, Mark E. J. Newman, 'Power Law Distributions in Empirical Data' *SIAM Review*, Vol. 51, No. 4 (2009), pp. 681–689.

25 Richardson, *op. cit*., pp. 523–546.

26 Lars Erik Cederman, 'Modeling the Size of Wars: From Billiard Balls to Sandpiles', *American Political Science Review*, Vol. 97, No. 1 (2003), pp. 135–150; Juan Camilo Bohorquez, Sean Gourley, Alexander R. Dixon, Michael Spagat, Neil F. Johnson, 'Common Ecology Quantifies Human Insurgency', *Nature*, Vol. 462, No. 7275 (2009), pp. 911–914; Lars-Erik Cederman, T. Camber Warren, Didier Sornette, 'Testing Clausewitz: Nationalism, Mass Mobilization, and the Severity of War', *International Organization*, Vol. 65, No. 4 (2011), pp. 605–638.

27 Aaron Clauset, Maxwell Young, Kristian Skrede Gleditsch, 'On the Frequency of Severe Terrorist Events', *Journal of Conflict Resolution*, Vol. 51, No. 1 (2007), p. 61.

Equation 1 shows that the scaling parameter α is sufficient to describe the shape of the power-law distribution. The scaling parameter hereby links the magnitude of a real or hypothetical violent event x with its probability of occurrence Pr(x). It is therefore the scaling parameter α that determines the heavy-tailedness of the distribution. The smaller the parameter, the more heavy-tailed is the power law and thus the higher is the risk that the distribution attaches to extremely violent events.[28] Both the heavy tails as well as the scale variance of power laws exhibit important implications for the prediction of violence against civilians in conflicts like the one we observe in Syria.

By estimating the scaling parameter it is possible to predict the occurrence of hypothetical events like a very extreme massacre if the violence within an actual armed conflict follows a power-law distribution. Leaving the details on how exactly to estimate power laws to the technically interested reader[29], it is important to know that there are three general steps in the identification of this kind of probability distribution.[30] In the first step, the scaling parameter α of the power-law distribution is estimated. Real empirical phenomena usually do not follow a power-law distribution for all values of the quantity of interest x. It is therefore necessary to estimate a lower bound called x_{min} for which x, in our case one-sided violence in Syria, is characterised by the power law. If both parameters are identified, the second step consists of assessing the plausibility of the estimated power-law distribution given the empirical data at hand. This includes both a test of the goodness-of-fit between the fatality data and the estimated power as well as an evaluation if other heavy-tailed statistical distributions (like the log-normal distribution and the stretched exponential distribution, also known as the Weibull distribution) provide a better model for death tolls in a given conflict.[31] If the power law survives these tests, scholars can then use the estimated power law to predict the probabilities for different violent events using a semi-parametric algorithm.[32] Predicting massacres with power-law distributions inevitably requires the identification of such a distribution. If, and only if, the power law offers a plausible statistical model of violent acts within an armed conflict, scholars can use the scaling parameter to predict such incidents.[33]

How ubiquitous are power-law distributions in conflict? Using data on violence against civilians[34] and the method developed by Clauset, Shalizi, and Newman[35], Scharpf[36] shows that violence against civilians is often power law distributed. Drawing on these results, Table 1 provides an overview on the presence of power-law distributions in data on violence against civilians. Out of the 49 civil conflict settings

28 Mark E. J. Newman, 'Power Laws, Pareto Distributions and Zipf's Law', *Contemporary Physics*, Vol. 46, No. 5 (2005), pp. 332–335; Cederman, Warren, Sornette, *op. cit*., p. 621.

29 See Clauset, Shalizi, Newman, *op. cit.*, pp. 661–703; Clauset and Woodard, *op. cit.*, pp. 1838–1865; Newman, *op. cit.*, pp. 323–351.

30 Code for implementing the methods used in this article are available under: http://tuvalu.santafe.edu/~aaronc/powerlaws/ and http://tuvalu.santafe.edu/~aaronc/rareevents/ (accessed 3 February 2014).

31 Clauset, Shalizi, Newman, *op. cit.*, pp. 661–703.

32 Clauset and Woodard, *op. cit.*, pp. 1838–1865.

33 The method requires a stationary production process of events. For the *ex ante* forecast, we use a window of 90 days. The statistical procedure we use here is data driven as it does not take into account spatial patterns in the occurrence of events or the influence of variables that might change the conflict process. We use different scenarios to account for an overall change in the conflict process.

34 Eck and Hultman, *op. cit.*, pp. 233–246; Schneider and Bussmann, *op cit*., pp. 635–644.

35 Clauset, Shalizi, Newman, *op. cit.*, pp. 661–703.

36 Adam Scharpf, *Massacres and the Power Law Explaining and Predicting One-Sided Violence*, Konstanz (2012), Master's-Thesis.

analysed, nearly half of them follow a power law.[37] In Europe and Latin America all conflicts follow a power-law distribution. This result is heavily influenced by the bloody disputes in Bosnia, Chechnya, and Colombia. While there are conflicts in Africa and Asia that can be described by a power law (for example, Rwanda, Uganda, Indonesia, Sri Lanka), there are almost as many conflicts that do not show such a pattern of violence (for example, DR Congo, Liberia, and India). Analysing the death tolls of conflicts in the Middle East, almost a third of these deadly quarrels show fluctuations in violence that support the power-law distribution.

Table 1: Power law distributed violence against civilians in civil wars.

Region	Power law	No power law	Total (%)
Africa	45.5% (10)	54.5% (12)	100.0% (22)
Americas	100.0% (2)	0.0% (0)	100.0% (2)
Asia	50.0% (2)	50.0% (2)	100.0% (4)
Europe	100.0% (5)	0.0% (0)	100.0% (5)
Middle East	31.3% (5)	68.8% (11)	100.0% (16)
Total (%)	49.0%	51.0%	100.0%
N	(24)	(25)	(49)

Note: Numbers in parentheses denote absolute frequencies. Due to different data sources and operationalisations frequencies do not correspond to the number of analysed conflicts.

Among these conflicts, the war in Bosnia is particularly well-suited to exemplify the political value of procedural predictions. In the following, we demonstrate how the methods sketched above provide the means to predict historically an event of the size of the Srebrenica massacre with at least 6,000 civilians killed between 1990 and 1995. Our data source is the *Konstanz One-Sided Violence Event Dataset*.[38] Because this event dataset codes several up-to-date news sources, the death toll it provides for the Srebrenica massacre deviates significantly from current estimates.[39] However, we argue that this does not pose a serious problem since in continuing conflicts like Syria competing parties have to rely on up-to-date news sources. Moreover, until quite recently news reports have been the only sources available on a daily basis that provided researchers with the necessary data to predict the risk of future atrocities.

Figure 1-A depicts the result for predicting one-sided violence for the war in Bosnia. It maps the power law in a plot with double logarithmised axes. While the x-axis shows the number of civilians killed, the y-axis depicts the probability of experiencing at least one event of size x or larger.[40] Among the displayed atrocities

37 Data sources differ considerably in terms of time coverage and operationalisations, which makes it difficult to provide a precise count of analysed intrastate armed conflicts. The study generally covers episodes of conflicts in 25 different countries. Conflict-specific results are given in Scharpf, *op. cit.*

38 Schneider and Bussmann, *op. cit.*, pp. 635–644.

39 Helge Brunborg, Torkild Hovde Lyngstad, Hendrik Urdal, 'Accounting for Genocide: How Many Were Killed in Srebrenica?', *European Journal of Population*, Vol. 19, No. 3 (2003), pp. 229–248; Potocari Memorial Center 2013: "Srebrenica – Potočari", available: http://www.potocarimc.ba/_ba/liste/nestali_z.php#z1 (accessed 3 February 2014).

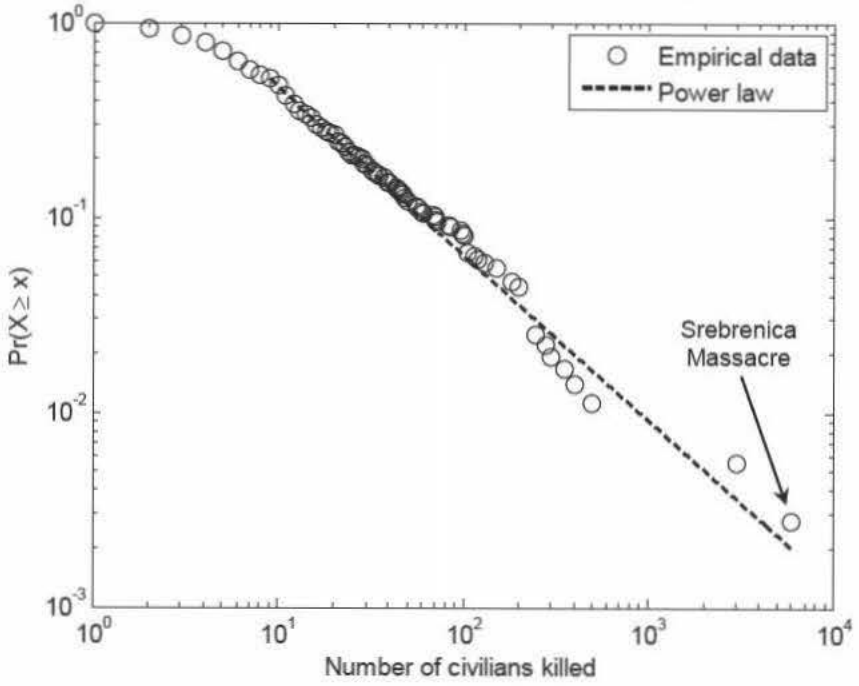
40 Given the logarithmised axes and the complementary cumulative density distribution function (cddf) $Pr(X \geq$

the Srebrenica massacre is readily identifiable. The estimated power law features a scaling parameter of $\alpha = 1.84$ ($\pm$ 0.08) which implies that the probability distribution is considerably heavy-tailed.[41]

Figure 1-B depicts our prediction results for the historical probability of the Srebrenica massacre.[42] Given the finite sample, we need to account for uncertainty in the estimated power law parameters, which is done by estimating slightly diverging power law models.[43] We account for uncertainty in parameters by estimating 10,000 bootstrapped power laws. 90% uncertainty intervals of the ex post probabilities are constructed by sampling 1,000 synthetic data sets from every bootstrap power law model. For the Bosnian war, we ascertain an historical probability of 49% (25%–73%) for at least one violent event of 6,000 or more civilians killed between 1990 and 1995.[44] These probabilities suggest that the massacre in Srebrenica was not a statistical outlier but rather a typical outcome of the process underlying this conflict.

Figure 1: Predicting massive violence against civilians during the Bosnian war, 1990–1995, using power laws.

1-A: Identifying the probability distribution of violence severity



Note: Data taken from *Konstanz One-Sided Violence Event Dataset* (KOSVED).

x), the power law is displayed as a straight line with a slope of α-1.

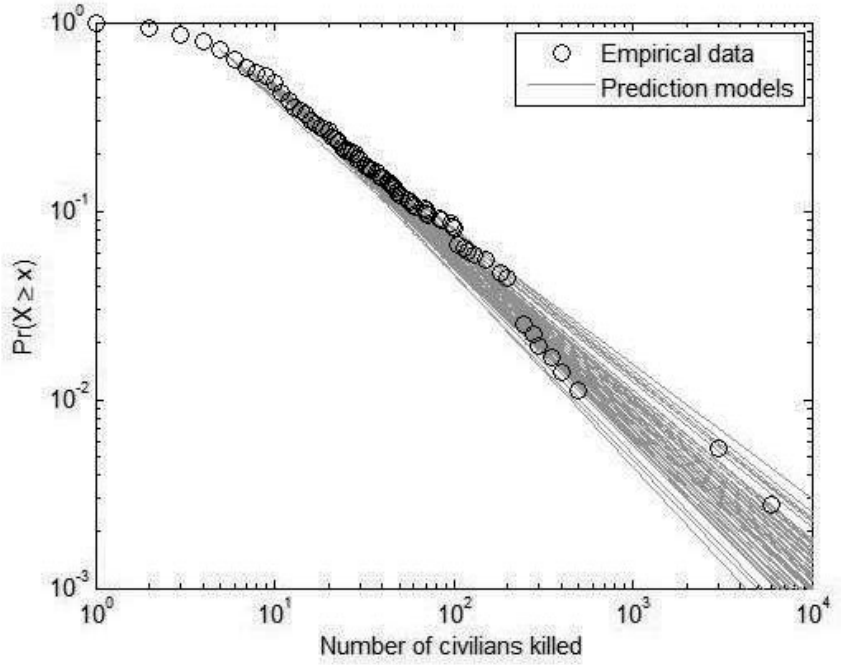
41 We checked the goodness-of-fit between the estimated power-law distribution and the data. The power-law distribution is a plausible model of the data. Please note, however, that this is also true for other heavy-tailed distributions which can therefore not be rejected as plausible models.

42 The Srebrenica massacre was excluded from the data before estimating its historical probability.

43 Clauset and Woodard, *op. cit.*, pp. 1840–1841.

44 The estimation method allows us to hold the lower bound of the power law models x_{min} constant. The resulting

1-B: Ex post prediction of the Sebrenica Massacre



Note: Figure displays 100 of 10.000 bootstrap power law tail models with varying x_{min} and scaling parameters. Data taken from the *Konstanz One-Sided Violence Event Dataset* (KOSVED).

Overall, our results pose the following question: had the international community been able to prevent the loss of more than 6,000 human lives, would it have had information on the risk of such an extreme act of violence to intervene swiftly and early on in the conflict? Critical readers might argue that it is always possible to criticise (in-)action of actors once in possession of substantive information after an event had occurred and in the knowledge of its far-reaching consequences. To account for such an objection and to provide political decision makers with readily usable information for their crisis management, we undertake a real-time forecast for the violence against civilians in Syria in the following section.

4. Reporting violent events in Syria

The following analysis will address the question of whether we need to fear another escalation of violence. We hereby use data from oppositional networks which have continuously monitored the number of civilians killed since the beginning of the conflict. A unique characteristic of the Syrian conflict is the publishing of body counts in real time. Organisations actively make use of internet platforms, social networks and other virtual means of communication and documentation to distribute

probability of the Srebrenica massacres remains with 47% (27%–68%) virtually unchanged.

data. The *Syrian Shuhada*[45] and the *Center for Documentation of Violations in Syria* (VDC)[46] allow direct access to their data. Access to other databases such as the *Syrian Revolution General Council* or the *Syrian Network for Human Rights*, the *Syrian Observatory for Human Rights* or the *March 15 Group* appears to be more difficult. Apart from these non-governmental organisations, the Syrian news agency *Sana* only releases sporadic reports which include victim-counts for single events[47] and hence cannot be used for a comprehensive documentation. The validity of these data is especially questionable if we take into account that the death counts of the Syrian regime deviate significantly from information provided by other sources.

A report by the human rights organisation *Human Rights Data Analysis Group* (HRDAG) published in January 2013 on behalf of the United Nations combines data from various Syrian sources. To date the United Nations and other international actors have rather confined themselves to vague estimates. According to the report, the casualty figure of the bloody struggle amounted to 59,648 conflict-related killings until the end of 2012[48] – a figure which was "much higher than expected" and "truly shocking" according to the United Nations and media.[49]

Calling validity and reliability of the victim-statistics into question by different actors is inherent in the debate of armed conflicts.[50] In the case of Syria, Guilliard[51] declares the published data of victims as an "intervention-propaganda of the West." It cannot be denied that the above mentioned Syrian NGOs follow political goals and are openly critical of the regime.[52] Little access for independent actors is particularly problematic in this respect, as Paul Sérgio Pinheiro, the Chairman of the Independent International Commission of Inquiry for Syria, points out.[53] In order to make use of the available data, criteria such as public access, comparability and verifiability, connection to local communities as well as the publication of disaggregated data are thus crucial.[54] In our analysis we therefore solely focus on sources that provide easy and

45 Syrian Shuhada (2013), available: http://syrianshuhada.com/ (accessed 07 March 2013).

46 VDC/Center for Documentation of Violations in Syria (2013), available: http://vdc-sy.org/index.php/en/ (accessed 4 February 2014).

47 BBC, "Q&A: Syria sanctions", *BBC News* (March 2012), available: http://www.bbc.co.uk/news/world-middle-east-15753975 (accessed 3 February 2014).

48 Megan Price, Jeff Klingner, Patrick Ball, "Preliminary Statistical Analysis of Documentation of Killings in the Syrian Arab Republic", *Bentech Human Rights Program* (January 2013), available at https://hrdag.org/wp-content/uploads/2013/02/Benetech-final-SY-report.pdf (accessed 3 February 2014).

49 UN News Centre, "Data Suggests Syria Death Toll Could Be More Than 60,000, Says UN Human Rights Office", United Nations (January 2013), available: http://www.un.org/apps/news/story.asp?NewsID=43866#.USoii2cepX5 (accessed 3 February 2014)

50 Peter Andreas, Kelly M. Greenhill, *Sex, Drugs and Body Counts The Politics of Numbers in Global Crime and Conflict* (Ithaca, Cornell University Press: 2010).

51 Joachim Guilliard, "Frisierter Body Count. Hintergrund. Zynisches Spiel: Die Bestimmung der Opferzahlen im syrischen Burgerkrieg dient als Interventionspropaganda des Westens", *Junge Welt* (February 2013), available: http://www.jungewelt.de/2013/02-06/007.php (accessed 06 February 2013).

52 In January 2014, the United Nations announced officially that it would stop updating their death toll due to problems with verifying the accuracy of numbers given by different Syrian sources. For details, see Kashmira Gander, "UN to stop updating death toll in Syria conflict", *The Independent* (January 2014), available: http://www.independent.co.uk/news/world/middle-east/un-to-stop-updating-death-toll-in-syria-conflict-9045096.html (accessed 4 February 2014).

53 UN Department of Public Information, "Press Conference on Independent International Commission of Inquiry on Syria", *United Nations* (October 2012), available: http://www.un.org/News/briefings/docs/2012/121016_Syria.doc.htm (accessed 3 February 2014)

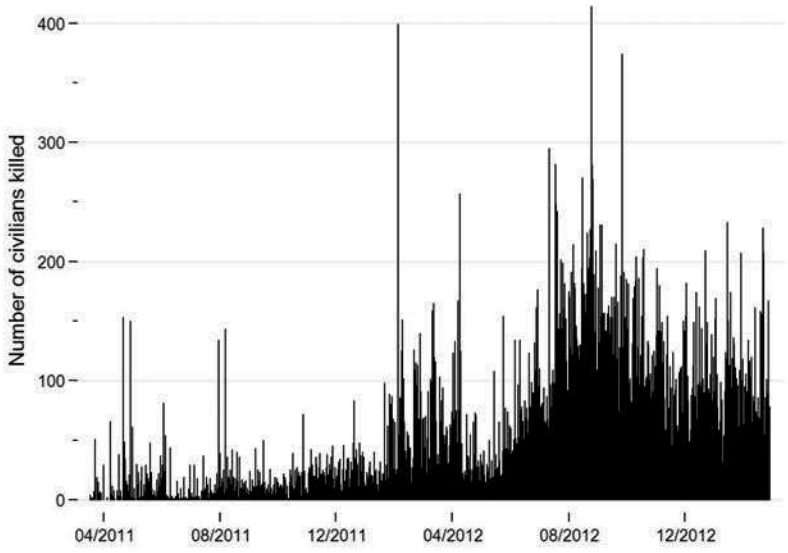
54 Elizabeth Minor, "Towards the Recording of Every Casualty: Analysis and Policy Recommendations from a Study of 40 Casualty Recorders", *Oxford Research Group* (October 2012), available: http://www.oxfordresearchgroup.org.uk/sites/default/files/TowardsTheRecordingOfEveryCasualty_0.pdf (accessed 3 February 2014), p. 16.

unrestricted access to their online databases. The website *Syrian Shuhada*[55] maintains a detailed database with information on the location, date and cause of death, as well as on the names, age and sex of the victims. Reports by the US *Congressional Research Service*[56] are mainly based on data of the *Syrian Shuhada*[57] database which draws upon varies sources including news sources, oppositional organisations and Facebook-groups to collect information (e.g. *The Martyrs of Syrian Revolution*).[58] It also lists VDC[59] as a source of information. The VDC, for its part, works together with oppositional activist networks, so-called *Local Coordination Committees*, and records according to its own statement "martyrs and detainees of the Revolution in line with international standards to document human rights violations."[60] Various Arabic and international NGOs refer to data of the VDC in their official statements.[61] The German news magazine *Der Spiegel* classifies the VDC-data as "so far very reliable"[62] and the *Foreign Policy Magazine* uses it for their analyses.[63] Because the *Syrian Shuhada*[64] database integrates data of the VDC[65] in their casualty figures, we draw on the former data source for our analysis. *Syrian Shuhada*[66] allows us to distinguish between civil and military casualties. To project the sufferings of the Syrian civil population as unbiasedly as possible, we will focus in our analysis exclusively on one-sided violence, meaning violence against civilians.

55 Syrian Shuhada, *op. cit.*
56 Jeremy M. Sharp, Christopher M. Blanchard, "Armed Conflict in Syria: U.S. and International Response", *Congressional Research Service* (July 2012), available: http://fpc.state.gov/documents/organization/195385.pdf (accessed 3 February 2014).
57 Syrian Shuhada, *op. cit.*
58 The Facebook *Group of The Martyrs of Syrian Revolution* can be found under https://www.facebook.com/Syr.Martyr.
59 VDC, *op. cit.*
60 *Ibid.*
61 These NGOs include *Human Rights Watch, Fédération Internationale des Droits de l'Homme or the Cairo Institute for Human Rights Studies.*
62 Rania Salloum, "Hier foltern Assads Agenten", *Der Spiegel* (July 2012), available: http://www.spiegel.de/politik/ausland/folter-in-syrien-human-rights-watch-veroeffentlichtneuen-bericht-a-842125.html (accessed 3 February 2014).
63 David Kenner, "The Grim Toll of Syria's Violence", *Foreign Policy* (November 2011), available: http://www.foreignpolicy.com/articles/2011/11/17/the_grim_toll_of_syria_s_violence (accessed 3 February 2014).
64 Syrian Shuhada, *op. cit.*
65 VDC, *op. cit.*
66 Syrian Shuhada, op. cit.

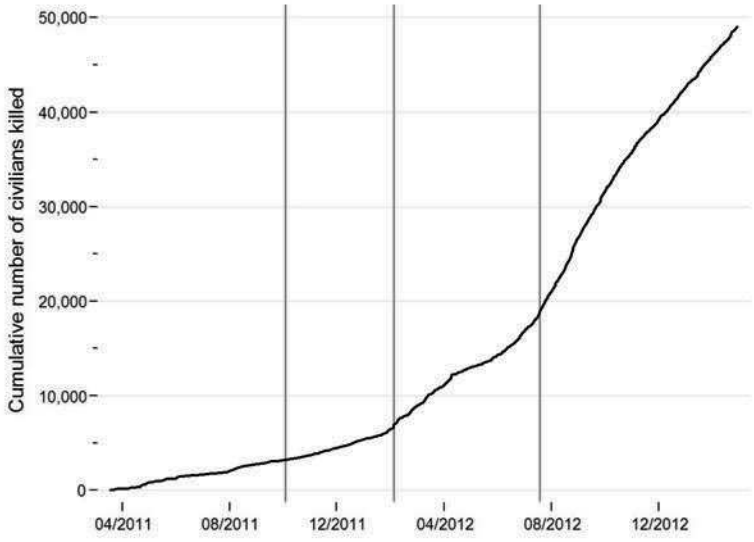
Figure 2: Trajectory of the Syrian conflict between March 2011 and February 2013.

2-A: Daily civilian death toll in Syria



Note: Data taken from the *Syrian Shuhada* database.

2-B: Cumulative civilian death toll in Syria



Note: Horizontal lines indicate vetoes in the UN Security Council. Data taken from the *Syrian Shuhada* database.

Figure 2 highlights the amount of violence from which Syria's civilian population has been suffering since spring 2011. The conflict has significantly intensified, as the daily numbers of civilian victims show in Figure 2-A. While days with a three-digit body count have been the exception during the first year of the conflict, the daily

number of civilians killed has clearly increased since the beginning of 2012. We can find the most violent days of the Syrian conflict in this time period, as Figure 2-A shows. The day with the highest number of victims until the end of February 2013 has been August 25, 2012 with 414 civilians killed, of whom 272 casualties alone are accounted for by the massacre in Daraya, a suburb of Damascus.[67] Only imperceptibly fewer civilians lost their lives on February 4, 2012. The death toll mainly stems from the military offensive in Homs, where 360 civilians were killed.[68] This day marks the bloodiest day in a Syrian province since the beginning of the documentation of one-sided violence in Syria. Also significant is August 26, 2012. On this day approximately 374 people died. The disaggregated data here leads us to conclude that the number of victims is not, as could be assumed, the sole result of a bomb attack in the heart of Damascus, but that another massacre took place in a suburb of Damascus.[69]

Starting with the deadly gunfire at protesters in Dara'a and Damascus in March 2012, the conflict has been geographically centred in the provinces of Hama, Homs, Dar'a and Idlib. Since the middle of 2012 the major cities of Aleppo and Damascus have also become places of clashes and massacres of the civilian population. This reflects the military strategy of the Syrian government and its affiliated militias. It seems to be the aim of the Syrian regime to maintain its power in the large cities such as Hama, Idlib, Dar'a and Latakia while combining this with a direct siege of "troubled" smaller towns by regime troops. The Syrian Army hereby seems mainly to focus on "kettling" cities through air strikes and tank shelling, while oppositional groupings primarily concentrate on strategic objectives such as oil fields or airports.[70]

While in individual cases the Syrian military seems to target civilians for tactical reasons, as recent reports about the massacres indicate, significant casualties amongst the civilian population are the result of intentional shelling and extensive bombardments of residential districts.[71] According to Figure 2-B, which shows the cumulative death toll over the trajectory of the Syrian civil war, violence against civilians shows no sign of declining. Until today the international community was not able to halt the violence in Syria. It rather appears that the suffering of the civil population has even been aggravated in the immediate context of the two veto-decisions in the UN Security Council. This raises the question of how likely different acts of violence in Syria have been in the past and will be in the future.

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67 Khaled Yacoub Oweis, "Assad's Forces accused of Massacre near Syrian capital", *Reuters* (August 2012), available: http://www.reuters.com/article/2012/08/25/us-syria-crisis-idUSBRE8610SH20120825 (accessed 3 February 2014).

68 Neil MacFarquhar, Anthony Shadid, "Russia and China Block U.N. Action on Crisis in Syria", *New York Times* (February 2012), available: http://www.nytimes.com/2012/02/05/world/middleeast/syria-homs-death-tollsaid-to-rise.html?pagewanted=all%20%20*Homs%20offensive (accessed 3 February 2014).

69 Kareem Fahim, "Syrian Insurgents Mount Fierce Attack on Military Compound in Damascus", *New York Times* (September 2012), available: http://www.nytimes.com/2012/09/27/world/middleeast/syria.html (accessed 3 February 2014).

70 UN Human Rights Council, "4th Report of Commission of Inquiry on Syria - A/HRC/22/59", *United Nations* (February 2013), available: http://www.ohchr.org/Documents/HRBodies/HRCouncil/CoISyria/A.HRC.22.59_en.pdf (accessed 3 February 2014); Damien Cave, "Syrian Forces Are Said to Expand Deadly 'Hit and Run' Efforts in Damascus", New York Times (August 2012), available: http://www.nytimes.com/2012/08/23/world/middleeast/Syria.html?pagewanted=all&_r=0; (accessed 3 February 2014).

71 UN Human Rights Council, *op. cit.*

5. Forecasting violent events in Syria

"Useful forecasts need to be produced in near-real-time."[72] Based on this principle, we undertake a risk forecast of extreme acts of violence in the Syrian civil war, making use of the *Syrian Shuhada* database.[73] Our unit of analysis is hereby the single governorate-day.[74] Drawing on the methods briefly introduced above, we start with predicting historical probabilities for at least one governorate-day with 250, 360, 500, 750, and 1,000 or more civilian deaths. In a second step we undertake an *ex ante* forecast of the violence against civilians for nearly three months starting on the March 1, 2013. We hereby predict the risk of observing at least one governorate-day with at least 125, 250, and 500 civilian casualties.

Based on the intensity of violence for 4,495 governorate-days recorded by the *Syrian Shuhada* database, we estimate a power law with $x_{min} = 45$ ($\pm$ 8) and a scaling parameter of $\alpha = 3.72$ ($\pm$ 0.33). The tail of the distribution quickly drops off which is the result of the relatively high value of the scaling parameter. This is especially apparent when we compare the power-law distribution for the Syrian civil war depicted in Figure 3-A with the power law of the war in Bosnia in Figure 1-A. In the Syrian case the power-law distribution is far less heavy-tailed. Thus, while we should expect extremely violent acts to occur in Syria, genocidal acts like the Srebrenica massacre seem to be highly unlikely.[75]

To substantiate our suspicion, we predict the historical probabilities of massacres of different sizes until the end of February 2013. The results of the *ex post* prediction are shown in Table 2 and Figure 3-B depicts the accompanying prediction models. The results demonstrate that while it has been reasonable to expect an increase in the severity of violence, we could have ruled out the occurrence of especially extreme violence since the beginning of the Syrian conflict. According to our prediction, for the bloodiest day in the Syria conflict with 360 civilian casualties in the Homs governorate there is a chance of nearly 47% (25.4%–68.7%). For at least one governorate-day with 250 or more civilians killed we estimate the risk as being as high as 79.8% (59.4%–94.1%). In the light of these substantial probabilities, we conclude that massacres are not single, random, and unforeseeable events.[76] Even an imaginary day in one of the 14 governorates with at least 500 deaths – these are over 100 victims more than the bloodiest day had claimed until the end of February 2013 in the whole of Syria – exhibits a substantial probability of 24% (10.6%–41.0%).

72 Patrick T. Brandt, John R. Freeman, Philip A. Schrodt, 'Real Time, Time Series Forecasting of Inter- and Intra-State Political Conflict', *Conflict Management and Peace Science*, Vol. 28, No. 1 (2011), p. 42.

73 Syrian Shuhada, *op. cit.*

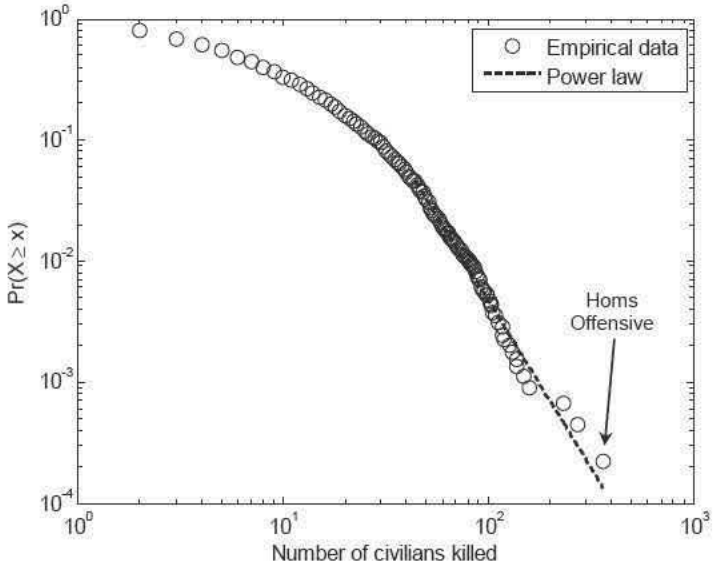
74 As the *Syrian Shuhada* database does not provide reliable spatial information, we aggregate the individual level data on the governorate-day level.

75 One could therefore argue that the gas attack in Ghouta was either the result of change in the overall conflict dynamic or that the casualty figures are lower than the ones reported by some Syrian sources.

76 See Stathis N. Kalyvas, 'Wanton and Senseless? The Logic of Massacres in Algeria', *Rationality and Society*, Vol. 11, No. 3 (1999), pp. 243-285.

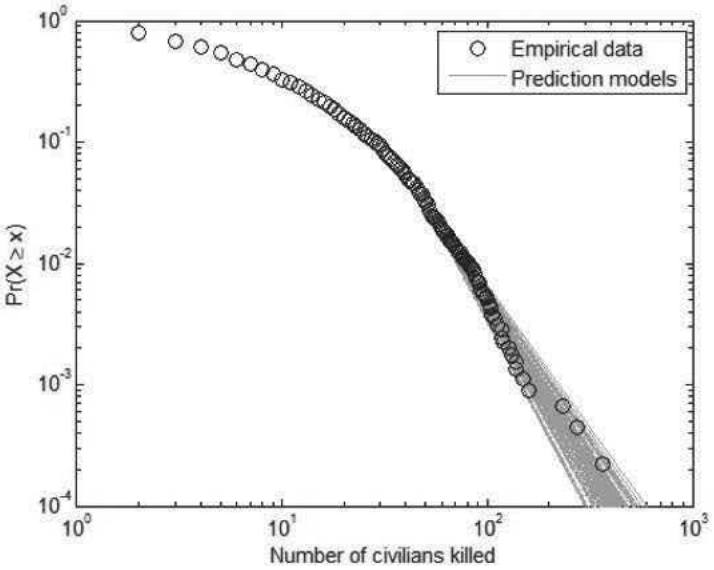
Figure 3: Predicting violence against civilians in Syria between March 2011 and February 2013 using power laws.

3 A: Identifying the probability distribution of violence severity



Note: Data taken from *Syrian Shuhada* database.

3-B: Ex post prediction of violence against civilians



Note: The figure displays 100 of 10,000 bootstrap power law tail models with fixed $x_{min} = 45$ and varying scaling parameters for a massacre of at least 250 civilians killed. Data taken from *Syrian Shuhada* database.

The results demonstrate how violence has escalated in the Syrian civil war up to the end of February 2013. However, and this is also shown by our results, an unlimited spiraling of violence is nearly impossible. With increasing death tolls, the probabilities of observing extreme acts of violence against civilians are significantly reduced. We estimate the risk of at least one day in one governorate with 1,000 or more civilians killed– that is four times the death toll of the most violent day in one of the Syrian governorates – to be about 4.4% (1.2%–9.5%). While there has been a constant risk of extremely violent acts since the beginning of the Syrian conflict, the occurrence of acts with intensities that significantly exceed previous death figures were not very likely.

Table 2: Historical risks of massacres in Syria between March 2011 and February 2013.

Number of civilian fatalities	Probabilities of occurrence	90% uncertainty intervals
250	79.8%	59.4% - 94.1%
360	46.7%	25.4% - 68.7%
500	24.0%	10.6% - 41.0%
750	8.9%	2.9% - 17.7%
1,000	4.4%	1.2% - 9.5%

Note: Ex post predictions are based on 10,000 bootstrap power law tail models with $x_{min} = 45$ and varying scaling parameters. Uncertainty intervals are calculated by sampling 1,000 synthetical data sets of each tail model. Data source is the *Syrian Shuhada* database.

Given our historical predictions, how likely is a further escalation of violence in Syria? To answer this question we *ex ante* predict the risk of observing one or more days with at least 125, 250, and 500 killed in one or more of the 14 Syrian governorates between March and May 2013.[77] Our prediction relies on two crucial assumptions. First, the power law needs to be a plausible tail model for extreme events of violence in Syria. Our statistical tests show that this is indeed the case. However, the tests also reveal that the log-normal distribution as well as the stretched exponential distribution cannot be refuted as plausible models of the data. The question of whether a phenomenon follows a power-law distribution or any other statistical distribution is highly relevant for the prediction of very extreme events that lie far out in the distribution's tail.[78] For events of medium size heavy-tailed distributions like the log-normal distribution or the stretched exponential distribution are perfectly able to mimic power-law distributions. For events of extreme magnitude this is not possible.[79] We therefore use all three probability distributions to predict the ex ante risk of massacres. Second, in order to forecast the likelihood of extreme massacres we need to assume a general trend in violence throughout our forecasting window.

77 To simplify statistical computation, we predict the risk of governorate-days with different death tolls for a 90 days window.
78 Clauset, Shalizi, Newman, *op. cit*., footnote 10.
79 Taleb, *op. cit.*, p. 396.

To cover a broad spectrum of potential developments, we construct three different scenarios. The 'status quo' scenario assumes that the number of violent events remains stable.[80] While the 'pessimistic' scenario is based on the assumption of a doubling of violence, the 'optimistic' scenario describes a halving of the number of violent governorate-days.

Table 3: Ex ante risk prediction of massacres in Syria from the beginning of March until the end of May 2013.

Number of civilian casualties	Tail model	'Optimistic' scenario with N_{90day} = 412	'Status quo' scenario with N_{90day} = 823	'Pessimistic' scenario with N_{90day} = 1650
125	Power law	65.1%	87.3%	98.1%
	Stretched exponential	61.6%	84.6%	97.3%
	Log-normal	60.1%	83.4%	96.7%
250	Power law	15.4%	28.2%	47.6%
	Stretched exponential	12.6%	23.3%	40.8%
	Log-normal	10.7%	20.0%	35.6%
500	Power law	2.6%	5.2%	10.0%
	Stretched exponential	1.9%	3.6%	7.1%
	Log-normal	1.3%	2.6%	5.0%

Note: Each ex ante prediction is based on 1,000,000 bootstrap tail models. Power law models feature $x_{min} = 45$. For each scenario, N_{90day} indicates the number of governorate-days with at least one civilian killed within the 90 day forecasting window starting on the 1st March 2013. Data source is the *Syrian Shuhada* database.

Table 3 shows the results of our predictions. For at least one day with at least 250 civilian deaths in one of the 14 Syrian governorates we calculate a probability between 11% and 48%. Taking into consideration that there were only two events within our whole period of study that exceeded this intensity of violence this is a clear indication that we should be prepared to experience more extreme massacres in the next three months. This result is further strengthened by our forecast of observing at least one governorate-day with 125 or more civilian casualties. We estimate a chance between 60% and 98% for such an event.

Aside from these worrying results, our prediction also shows that a general cooling-down of the conflict leads to a substantial reduction in the risk of extreme massacres. If the number of days throughout Syria that feature civilian deaths are reduced by one half, the probability of a massacre with at least 250 deaths occurring falls below 16%, while for a massacre with at least 125 it decreases from 87% to nearly 60%. Moreover, given the data at hand our results suggest that an extreme massacre with at least 500 civilians killed within one or more days in one of the governorates

80 The construction of scenarios is based on the overall number of governorate-days with at least one civilian casualty as well proportion of events with at least 45 deaths between 30th November 2012 and the 28th February 2013. Given this time span, our dataset contains 823 deathly governorate-days of which 34 feature 45 or more killed civilians.

is relatively unlikely to occur. The chance of such an event is not more than 10% even under the pessimistic scenario.

Overall our results support two broad conclusions: If the international community does not engender a political or military solution of the Syrian conflict in the next couple of weeks and months, we have to be prepared to observe further atrocities and war crimes in the near future. But a genocidal escalation of violence like the one we observed in Bosnia is – and from a humanitarian point of view that is the positive implication of our analysis – highly unlikely.

Evaluation:[81] How accurate are our forecasts? The overall aim of this article is to provide policy makers with an early warning system to assess the risk of extreme massacres. Accordingly, we focus on a massacre of 500 civilians killed to evaluate the accuracy of our model. Readers may keep in mind that in the data that we use to train our model the most severe event exhibits 360 killed civilians. We therefore consider the prediction of a fictional governorate-day of 500 civilian deaths to be a crucial test to our system. Given the extremely rare character of events of this size and the highly disaggregated nature of our data, we argue that a risk of greater than 1% for an event of this magnitude should be a strong alarm for political decision-makers to react to the continuing violence. To assess the accuracy of our ex ante prediction we collected data from the *Syrian Shuhada*[82] database for our 90 day forecasting window which were not available at the time we undertook our forecast. The data shows that the overall level of violence in Syria has remained relatively stable. There are 861 governorate-days of deadly violence against civilians. The 'status quo' scenario which consists of 823 governorate-days provides us thus with the appropriate setting to evaluate our forecasts.

Looking at the 'status quo' scenario in Table 3, we estimate the risk of observing at least one extreme event with 500 or more civilians killed to be twice the probability of our benchmark for rare and extreme events under the log-normal distribution. Under the power-law distribution the likelihood increases five-fold. With this information at hand, policy makers should therefore have expected such a governorate-day of this magnitude to occur.

Checking the data for our forecasting window between March and May 2013, we observe that there is indeed one governorate-day of such magnitude. On April 21, government forces re-captured the city of Jdaidet al-Fadl outside of Damascus in the governorate of Rif Dimashq after several days of heavy fighting. On the last day of fighting, the Syrian Army allegedly perpetrated a massacre by summarily executing civilians.[83] *Syrian Shuhada*[84] reports the deaths of 503 civilian for this day thereby marking the most violent day in one of the Syrian governorates since the start of the civil war. Based on our forecast probabilities our early warning system has not only predicted the occurrence of this massacre but it could have put decisions-makers in a position of anticipating this event and of undertaking adequate steps to prevent this tragic event from occurring.

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81 The evaluation of our forecast was not part of the original article published.

82 Syrian Shuhada, *op. cit.*

83 BBC, "Syria army seizes Jdaidet al-Fadl ‚killing dozens'", *BBC News* (April 2013), available: http://www.bbc.co.uk/news/world-middle-east-22240540 (accessed 3 February 2014).

84 Syrian Shuhada, *op. cit.*

6. Discussion and conclusion

Our analysis reveals clearly that the lack of an early humanitarian intervention exacerbated the danger of a further escalation of the violence in the beginning of 2013. We are, based on this result and similar studies, convinced that decision-makers should resort more systematically to dynamic conflict forecasts as these predictions not only enable them to assess the risk of extreme human rights violations and war crimes but also to strengthen those measures that improve the security of civilians. [85] Fortunately, there is an increased interest of some Western decision makers in early warning. This tendency is simultaneously reflected in the growing importance of conflict forecasts in quantitative conflict analysis.[86]

However, such predictions cannot - and should not – prejudice the choices of the responsible political leaders; they can also not replace other fundamental ingredients of the decision-making process. But structural predictions that forecast the risk of conflict in the near future for countries and regions comparatively, should become as much a routine of the decision-making process as the dynamic forecasts which we have presented in regard to Syria. Only in this way can we ascertain that the extreme violence levelled against the population in a region can be systematically anticipated and prevented. We believe that the problem that our forecasts develop into 'self-fulfilling prophecies' is rather small for Syria. Graham Greene and John Le Carré describe in their parodies *Our Man in Havana* and *The Tailor of Panama* this moral dilemma that any conflict forecast faces. The spy novels show how agents contribute involuntarily through their invented events to the escalation of a conflict. Conflict forecasters can obviously not completely shield themselves against the danger to over- or underestimate the potential for conflict escalation through their usage of faked information or through the unavailability of reliable data. A biased informational basis will force them – voluntarily or involuntarily – to side with one of the warring parties. This risk of biased forecasts is, however, smaller in the Syrian case because of the surprisingly detailed victim statistics that various NGOs provide. Nevertheless, we cannot completely exclude the possibility that the sources consulted overestimate rather than underestimate the number of victims. Extensive reliability checks would obviously counter this risk, but this could only be done with a certain delay, preventing conflict forecasters from estimating the risk of escalation *ex ante* and reducing the value of systematic predictions for early warning. We believe that the radical alternative to repudiate completely the analysis and the prediction of actual political violence is morally more objectionable. The scepticism against forecasts is all too often based on the prejudice that (quantitative) conflict research does not possess any practical relevance. It is clear that forecasts can be far off the mark. But even if this is the case, we hope that we have contributed to an objectification of the debate about the responsibility of the West in the Syrian civil war and that we have illustrated the need to use scientifically based early warning mechanisms in crisis decision-making.

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85 See Jay Ulfelder, "Making a Case for (Imperfect) Statistical Modeling as the Basis for Genocide Early Warning", available: http://www.ushmm.org/m/pdfs/20111021-ulfelder-early-warning.pdf (accessed 3 February 2014).

86 Christoph Meyer, Florian Otto, John Brante, Chiara de Franco, 'Re-casting the Warning-Response-Problem: Persuasion and Preventive Policy', *International Studies Review*, Vol. 12, No. 4 (2010), pp. 556-578; Gerald Schneider, Nils Petter Gleditsch, Sabine C. Carey, 'Exploring the Past, Anticipating the Future: A Symposium', *International Studies Review*, Vol. 12, No. 1 (2010), pp. 1–7.