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Scale invariance in the 2003–2005 Iraq conflict ☆

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Abstract

The number of reported social systems that apparently display power-law correlations (i.e., scale-free patterns) has increased dramatically in recent years, ranging from city growth and economics to global terrorism. Using the set of violence events in the 2003–2005 Iraq stabilization phase (i.e., from May 1, 2005), existence of scale-free patterns in event fatalities is shown. This property is also present in the tail of distributions of events divided into groups based on the type of used weapon. Lognormal distribution description was also tried, showing the superiority of the power-law function to describe the behavior of heavy tails. Time series for civilian and military fatalities were studied using the so-called detrended fluctuation analysis. Civilian fatalities showed uncorrelated behavior, implying a lack of memory effects on the evolution of daily civilian fatalities. In contrast, military fatalities displayed long-range correlated behavior.

Keywords: Scale invariance; Power law; Lognormal; War; Fatalities

1. Introduction

Power-law statistical relation between an observed variable and its occurrence frequency is well understood to be an ubiquitous feature of both natural and social systems. The existence of power-law distributions demonstrates the absence of a characteristic size event, unlike with a normal distribution. Thus, there is no fundamental distinction between events at different scales, and large catastrophic events of all sizes occur more often than one normally expects. Power-law distributions occur in an extraordinarily diverse range of phenomena, ranging from phase earthquakes to economics. Recent reviews [1–3] provide an interesting survey and possible explanation of many natural and social systems where power laws are apparent, including word frequency in a novel, number of citations to a scientific paper, population of cities, etc.

Most studies on scaling properties of social systems have focused on non-conflictive social (economic and finances) systems. For instance, studies of the S&P500 financial index have shown the presence of heavy tail, reflecting potentially catastrophic events [4]. Similar distributions have been detected in the number of e-mail messages that people send and receive [5]. It should be clear that statistical studies of this type had been

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possible thanks to the available large amount of data by modern electronic mass media. Recently, data from quantitative tracking of social systems under violent confrontation have been made available in open scientific publications and Internet public domains. Richardson [6] reported basic statistics on the frequency and intensity of wars. Specifically, he decided first to find out how wars were distributed according to their size by plotting the fatality statistics for 82 wars fought since 1820 on a graph showing the size of the conflicts on one axis and the number of conflicts of that size on the other. The existence of a decreasing power-law behavior was shown, implying that there are progressively fewer conflicts of ever-greater size: little wars are common, big ones rare. The cumulative distribution of the intensity of 119 wars from 1816 to 1980 was studied by Robert and Turcotte [7], showing fractal scalings in the relations between the intensity of a war and its return period.

Terrorism is a particular type of unilateral violent conflict defined as the attack on unarmed civilians [8]. Telesca and Lovallo [9] detected correlation structures in global terrorism, showing evidence that terror attacks are not fully independent among them. Percolation theory [10] and theory of complex adaptive systems [11] have been used to propose strategies oriented to reduce the terrorism potential. Clauset and Young [12] used tools of extremal statistics to analyze the set of terrorist attacks worldwide between 1968 and 2004, finding that the relationship between the frequency and severity of terrorist attacks exhibits the ''scale-free'' property with an exponent of close to two. Interestingly, the scale-free property resulted to be robust even when the analysis was restricted to events from a single type of weapon. Recently, Johnson et al. [13] studied the frequency–intensity distribution of civilian killed in Colombia and Iraq conflicts, showing strong evidence for power-law behavior for these two contemporary violent conflict. Despite substantial differences in contexts and data coverage, it was demonstrated that the power-law coefficients for both wars are tending toward 2.5, which is a value characteristic of non-G7 terrorism as opposed to old wars [12].

Violent confrontations disturb seriously the social development by obstructing economics and cultural dynamics [8]. Therefore, it needs to be investigated using all possible approaches. The aim of the present paper is to study the distributions of both civilian and coalition military deaths resulted from the 2003–2005 Iraq war. To this aim, publicly available data extracted from the Internet site http://www.iraqbodycount.net were used and classified into event severity, type of weapon used and the number of daily civilian and military deaths. Our analysis extends a previous findings on the fatality distribution for Iraq war [13] by showing the following:

- Scale invariance is also a robust property of severity distributions for different types of weapon used (e.g., firearm, vehicle bomb, etc.).

We carried out a further analysis to reveal that the Iraq war presents the following features:

- The fatality distribution of coalition military fatalities also displays a power-law behavior in the heavy tail range. However, there is no sufficient evidence to reject a lognormal description in the whole severity range.
- A detrended fluctuation analysis [14] was used to look for memory (i.e., correlation) phenomena in severity time series. Our analysis showed a lack of correlation effects in the dynamics of daily civilian deaths. In contrast, coalition military deaths displayed correlated behavior.

In this form, our results should be seen as an additional support to previous findings [12,13] suggesting that scale invariance is a dominant phenomena within contemporary wars.

2. Data

Reported civilian and military deaths in the 2003–2005 Iraq war are available at the public site iraqbodycount.net. The database includes all civilian and military deaths. Casualty figures were derived solely from a comprehensive survey of respected *online media reports* (i.e., CNN, NY Times, etc.). Each record includes the date, target, city, type of weapon used, information source, and estimates of minimum and maximum number of fatalities (i.e., deaths). All results were independently reviewed and error-checked by at least three members of Internet site team before publication.