

War and scientific output moving beyond war

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Introduction

War has resulted in devastating effects on health throughout human history [1]. Like a cancer, it destroys the normal functions of the society, spreads rapidly leaving destruction in its wake, and is the most serious threat to millions of lives. The effect of war on scientific output may also be huge. It can be precisely measured by changes in the number of papers from affected areas published in the peer-reviewed scientific journals indexed in the *Science Citation Index (SCI)* [2]. We have recently shown that the scientific output from a country at war in its own territory was drastically reduced [3,4]. These data parallel the human tragedies as well.

The purpose of this study was to assess the damage of the civil war, the United Nations (UN) sanctions, and NATO military interventions during the forceful disintegration of the former Yugoslavia on scientific output as measured by changes in the number of publications indexed in the *SCI* from two of the cities that were affected, Sarajevo and Novi Sad. Also, this study set out to follow a recovery of such damage in the postwar period.

Methods and Results

The articles published in English from 1987 to 2003 in journals indexed in the *SCI* were retrieved for the two cities from the former Yugoslavia: Sarajevo, affected by the civil war in Bosnia & Herzegovina (B&E) from 1992 to 1995, and Novi Sad, Serbia, hurt by the economic sanctions (imposed in 1992 and lifted in 2001) and by the 78-day NATO bombing in 1999. Istanbul, Turkey and Ljubljana, Slovenia were used as controls.

In 1987, Sarajevo, Novi Sad, Ljubljana, and Istanbul produced 25, 80, 321, and 133 articles, respectively. Sixteen years later, these cities produced 31, 140, 1,548, and 2,188 articles, respectively. Thus, in 2003, Sarajevo, Novi Sad, Ljubljana, and Istanbul produced 1.2, 1.7, 4.9, and 16.4 times more articles, respectively, than in 1987. During the prewar period, the annual scientific output from Novi Sad and Sarajevo gradually increased, but the output from Sarajevo declined sharply to 11 articles in 1995. The output from Novi Sad also dropped in 1994 and 1995. A modest increase in output from these two cities followed during the postwar period (Figure 1). The scientific output from Sarajevo has recovered very slowly.

Discussion

The scientific output from Sarajevo and Novi Sad was reduced during the war, and its postwar production increase was far behind the control cities. Before the war, scientific research in the former Yugoslavia was pursued vigorously, especially in the oldest and well-established universities of Belgrade, Zagreb, and Ljubljana [3]. Historically, the various republics of the former Yugoslavia had had an unequal distribution of scientific institutions among them. To rectify this inequality, the former Yugoslavia had

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	Novi Sad	Sarajevo	Ljubljana	Istanbul
1987	80	25	321	133
	98	29	340	158
1989	115	38	363	190
	108	39	440	238
1991	117	40	444	277
	127	36	546	320
1993	123	18	579	316
	108	17	577	398
1995	113	11	633	475
	187	15	787	808
1997	141	13	931	830
	182	20	902	1000
1999	134	10	1159	1159
	137	15	1405	1230
2001	141	20	1384	1480
	124	25	1399	1821
2003	140	31	1584	2188

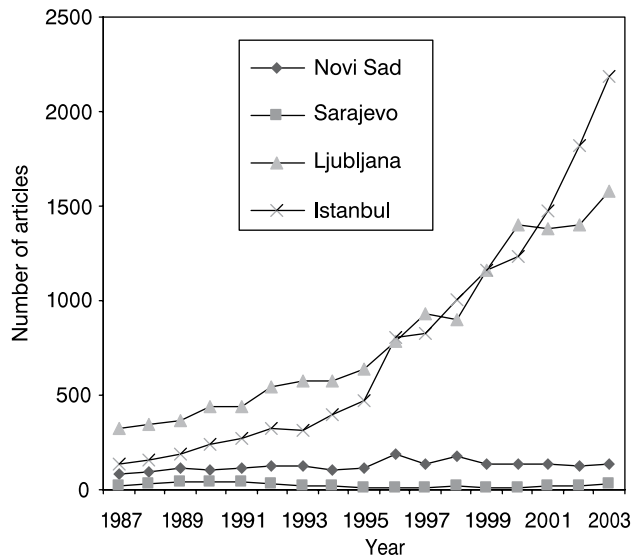


Figure 1. Number of articles indexed in the SCI from Novi Sad, Sarajevo, Ljubljana, and Istanbul.

opened many new universities, so that before the civil war the country had as many as 18 universities among its various republics. Their distribution was proportional to the population in the 6 republics of the former Yugoslavia. Thus, Serbia had 5 universities, Croatia and B&H each had 4, Slovenia and Macedonia each had 2, and Montenegro 1. In the late 1980s, Serbia produced more than 900 scientific articles per year and was well ahead, with twice as many publications as Slovenia. The number of publications from Croatia fell between that of Serbia and Slovenia [3]. The outputs from B&H and the remaining republics had a relatively small scientific presence. Thus, the output from B&H in 1991 was 50 articles, and more than half of them originated from the University of Sarajevo and from non-university institutions from Sarajevo. Although the scientific output from the majority of the new universities was modest, some of them, such as the University of Novi Sad, significantly increased their yearly scientific production that before the war reached about 100 articles per year.

The war suppressed the scientific vitality mainly in Serbia and B&H. These former Yugoslav republics were not as scientifically productive in the postwar period as Slovenia [4], the state that was only peripherally involved in the civil war. The scientific production in B&H and in Serbia was affected not only by the devastated economy, damaged communications, and the hardship of everyday life during the war and

postwar years, but also by the exodus of many top scientists and by the lack of outside support [5]. Using a "Salton Index" [6] to calculate the amount of international co-authorship between scientists from Serbia, Croatia, and Slovenia from 1986 to 1995 as well as between each of these and 5 western countries (Germany, France, Italy, United Kingdom, and the USA), we determined that Serbia seems to be scientifically relatively isolated from 1992, when the UN sanctions to this state were imposed [3] to the present (although these sanctions were officially lifted, some of the restrictions still remain).

In Turkey, as in many countries, scientists are under constant pressure to publish. This pressure forces some scientists to sacrifice quality for quantity [7]. Even so, the pressure to publish is a stimulus that motivates research activity. However, an increase of scientific output generally follows national income, research budgets, academic staffs, and international scientific communication.

Devastated countries cannot afford to finance many scientists, as research is a rather expensive enterprise. Therefore, in war-torn countries, those who are responsible for financing science should select the most promising researchers, preferably trained in developed countries [8]. Also, because we are one intellectual community [9], researchers from other countries should continue to survey scientific activity in the areas affected by war and help restore and

upgrade research and publication. Scientists in the international community can aid their colleagues in the damaged areas by maintaining communication, establishing collaborative ventures, and offering exchange programs and advice. In addition, gifts of scientific books and journals as well as equipment and supplies would be welcome. As Eugene Garfield stated [9], "Supporting scientist-colleagues in such countries is in our best interest".

To protect society, man must solve the problems relating to huge differences in development, distribution of power, and natural wealth. The international community under the auspices of the UN has to find a way to carry out this obligation. Scientists and other scholars can force politicians, soldiers, and diverse public workers to work toward peace and prevention of war. Because war is a medical problem, medical doctors have a special opportunity and obligation to fight for peace. By engaging people's attention to questions and possibilities that transcend all national, religious, economic, and social differences and by providing hope for a better future, medicine could be a powerful instrument for concord. Gathering medical professionals from various countries to give their opinion on this important topic, the prevention of war and other war-related major threats to the health of global society, could be the basis for the permanent preventive activities of our profession. Perhaps Athens, due to its role in origin of Western civilization, could be the best place for such gatherings that may produce a significant contribution to modern human-rights movement that was born from the devastation of World War II. The Declaration of Human Rights

that emerged after the large scale tragedy was signed in liberated Paris, but it has mainly remained as an empty gesture. Thus, it is the challenge for this Century to make the Declaration reality [10] and violence of all kinds preventable [11]. The Chilean poet, Pablo Neruda, composed a message that sadly the majority did not get: "Oh beautiful is this planet; I came to live in this world."

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