

# **Basic Demographic Characteristics and Socio-Economic Status of Missing and Killed Persons from the Municipality of Prijedor, 30.04-30.09.1992**

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**September 9, 2002**

## **Summary of Results**

This report presents statistics concerning persons from the municipality of Prijedor who were reported killed or missing from 30 April to 30 September 1992. The report was prepared by the demographic unit of the Office of the Prosecutor (OTP) for the case of the Prosecutor of the Tribunal vs. Milomir Stakić, Case Number IT-98-24. The author utilised three sources for data on those missing or killed: The International Committee of the Red Cross (ICRC) List of Missing Persons, *Knjiga Nestalih* of Prijedor (KN), and the Exhumations Database and Proof of Death Databases (EXH). The latter two databases were compiled by the OTP from documents concerning exhumations and Bosnian courts' Declarations of Death. The identities of all those listed in these documents were verified by comparing the names and data concerning the individual to the 1991 census conducted by the government of Yugoslavia. As a further check, the names of those listed as missing or dead were compared to the voter lists for the 1997 and 1998 elections in Bosnia, to ensure that no individual was incorrectly listed as missing or dead who had actually voted in either of these elections.

The following are the principal findings from the analysis of the data:

- The three sources together include 2,789 names.
- The individuals listed in the databases were compared to the names and other details of individuals in the 1991 census. If the individual was identified in the 1991 census, the name was then compared to voters lists compiled by the Organisation of Security and Co-operation in Europe (OSCE), Regional Office for Bosnia and Herzegovina, for the 1997 and 1998 elections. Any name that also appeared on one of these voter lists was then removed, since in such a case the individual had possibly<sup>1</sup> survived the conflict.
- We also compared the names on the lists of missing, exhumed or declared dead with each other and removed any duplicates, that is, any name that appeared in more than one of the three databases of those reported missing, exhumed or declared dead.
- The above-mentioned process reduced the original list of merged names (2,789) to a total of 1,731 unique individuals. These individuals were all identified in the 1991 census and their name did not appear on the 1997 or 1998 voter lists. At the same time, ICRC or KN had reported them as missing in 30.04-30.09.92, or they had been on a list of those exhumed with indications he or she was killed in 30.04-30.09.92, or declared by a court to have died in this period.
- This number of 1,731 names clearly understates the total number of persons who were killed in 1992 since undoubtedly some individuals who were killed were not reported missing by family members, no one obtained a certificate of death for them and their body has not been exhumed and

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<sup>1</sup> Inconsistent evidence may also indicate registration fraud.

identified. In order to provide some insight into the actual number of victims from Prijedor who were killed during this time period, the author utilised a recognised statistical tool for making such estimates (i.e. the capture-recapture method). The three databases have been used to produce a stochastic estimate of the total number of victims from Prijedor by using the capture-recapture method, which is further explained in the annex to this report. This method results in an estimate that some 2,190 persons from Prijedor were killed or went missing in 30.04-30.09.92.

- The vast majority of missing/killed persons from Prijedor were Muslims (1651 persons out of 1,731, 95.4 % of all victims).
- The most affected age groups were from 20 to 49 years (1,313), and most victims were men (1,665).
- We however have also found children (77 individuals; age 0-18 years), women (65 persons), and elderly (61 persons; age 65+) among the victims.
- The number of victims from Prijedor was the largest among all municipalities in the Autonomous Region of Krajina in 1992, and those from Prijedor who went missing or got killed in 30.04-30.09.92 constituted the vast majority of all victims in 1992.
  
- We also studied the socio-economic status of those missing or killed, i.e. their educational attainment and occupational status.
- We found that persons with secondary or post-secondary level of education, especially Muslims, had higher risks of missing/killed than persons with lower education. However, also those with elementary education were characterised by relatively high risks of missing/killed. In addition to that, persons with the highest education did not always show the highest risks of missing/killed. Thus, the pattern found in our lists of missing/killed does not consistently indicate the existence of education-related targeting of the Prijedor population.
- Unlike the education - oriented targeting, an occupational status – related selection could be clearly seen. We found for all Non-Serbs, but most evidently for Muslims, that two uppermost categories on the occupational position, i.e. owners and self-employed with their aid, consistently showed the highest risks of missing/killed. Two lower categories, inactive and employees, consistently had the lowest risks of missing/death. Moreover, one can even speak about a systematic, regular increase in the risks of missing/killed associated with the socio-economic gradient in the occupational status. The risks for Muslims were the highest among all three Non-Serb ethnic groups, but the same patterns basically emerged also for Croats and Others. The results for men indicate essentially the same pattern, the risks being considerably higher due to the fact that the vast majority of victims from Prijedor were men.
- We also estimated differences in the risks of missing/killed by comparing the risks for a given group with the risks of occupationally inactive Others. Statistical significance of these differences was estimated as well.
- Relative risks of missing/killed Muslims were all statistically significant and the highest among all ethnic groups. The pattern obtained for Muslims consistently indicated a socio-economic targeting of this ethnic group with the occupational status as the targeting mechanism.
- Croats and Others were also affected groups in Prijedor and their risks of missing/killed were consistently the highest for those self-employed with aid and also those with secondary and post-secondary education. This result indicates some kind of targeting too, but for both SES variables the difference in risks of missing/killed between Croats and inactive Others was statistically insignificant suggesting comparable losses among these two ethnic groups.

## 1. Introduction

This report utilises three sources of information about missing and killed persons from the municipality of Prijedor who went missing or were killed in the period from 30 April to 30 September 1992. The major source for missing persons from Prijedor is the ICRC List of Missing Persons. Two more sources available to us were *Knjiga Nestalih* from Prijedor and the Exhumations and Proof of Death Databases established recently at the Office of the Prosecutor for the purpose of obtaining a better insight into the crimes committed in the Autonomous Region of Krajina (Sébire, 2001)<sup>2</sup>. The three sources are briefly summarised in Annex A1.

In Section 2, the numbers of victims found in each source are presented, the overlap between the sources is analysed and the three sources are used together to produce a stochastic estimate of the total number of victims from Prijedor. We also show basic demographic features of the Prijedor victims, such as their sex, age, and ethnicity.

Section 3 of this report concentrates on the socio-economic status of the victims by studying their educational attainment and occupational position.

## 2. Victims from Prijedor Absolute Numbers and Basic Distributions

### 2.1 Absolute Numbers

Using the three sources<sup>3</sup> discussed in Annex A1, we identified the following total numbers of victims from the municipality of Prijedor (hereafter Prijedor), who were killed or disappeared in the period from 30 April to 30 September 1992<sup>4</sup>:

- ICRC: 1,063 (of the total of 1,168 ICRC records linked with the 1991 census for Prijedor)
- KNP: 1,088 (of the total of 1,953 KNP records linked with the 1991 census for Prijedor)
- EXH: 638 (of the total of 1,122 EXH records linked with the 1991 census for Prijedor)

Altogether the three sources add up to 2,789 individuals, all of which were matched with the 1991 population census. By linking with the census, the identities of 2,789 victims were confirmed. In the remainder of this section we analyse only those victims linked with the census and not all victims reported in the three sources. We do that to ensure the reliability of the analysis, and in particular to avoid any double counting of victims from different databases and exclude inconsistent records (e.g. records of missing or dead persons reported also as survivors in voters registers).

The total of 2,789 names comes from the three sources, which are independent but also overlapping. A person reported to ICRC as missing could be also listed in the *Knjiga Nestalih* from Prijedor, later the same persons could be identified in exhumations, and a request to declare the individual dead could be

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<sup>2</sup> Nicolas Sébire, 2001, "Exhumations and Proof of Death, Autonomous Region of Krajina". OTP Report.

<sup>3</sup> The source excluded from the analysis was MAG, which for Prijedor contained mainly the same information as the ICRC and KN lists of missing. There were only 23 records in MAG relevant to STAKIC that were *not overlapping* with ICRC, KNP, and EXH lists. Because of the repeated records and for simplicity of calculations (i.e. the capture-recapture method), we decided not to include MAG in the analysis.

<sup>4</sup> All totals discussed in this section do not contain inconsistent records, i.e. persons identified on the lists of dead and at the same time on the 1997/98 electoral lists.

made at the municipal court. To avoid any possibility of double counting, we removed duplicates from the list of merged sources and arrived at the total number of **1,731 unique victims** (only persons identified in 1991 population census were considered, see Figure 1 below):

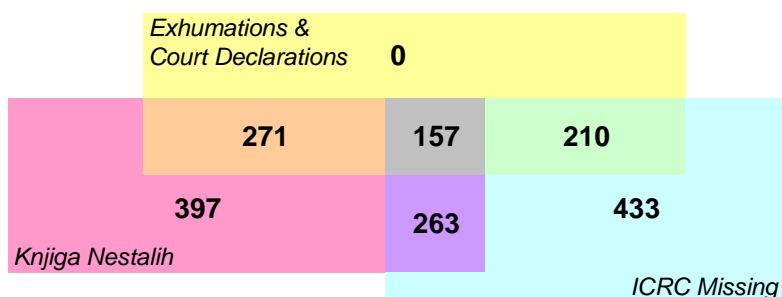
The overlap of sources was the following:

- ICRC and KNP: 263 individuals
- ICRC and EXH: 210
- KNP and EXH: 271
- ICRC, KNP, and EXH: 157

The unique parts of the three sources are given below:

- ICRC: 433 individuals
- KNP: 397
- EXH: 0

**Figure 1. Overview of Sources for Verified Victims from Prijedor Municipality**



The total number of victims from Prijedor (1,731) comes from all three sources together and is checked for duplicates and inconsistent records. However, it is reasonable to believe that the actual number of victims is higher than this figure since some individuals, particularly where entire families were killed, may not have been reported missing, no one may have sought a declaration of death and the corpses may not have been exhumed and identified, particularly where there are no close family members remaining to make the identification. Finally, the matching process is imperfect and a number of records relevant to the STAKIĆ case have not been linked with the census (usually about 20% records remain unlinked).

In order to present a closer approximation of the actual population loss, we applied the so-called capture-recapture technique<sup>5</sup> to stochastically estimate the victims from Prijedor (Bishop, Fienberg and Holland, 1975). The method allows for computing both the recorded and the unrecorded numbers of events (i.e. missing and killed) using several quasi-independent sources. The ICRC List of Missing Persons was considered to be the most systematically taken and broadest among the three sources at our disposal. In this case, the variance estimator for the capture-recapture estimate of the Prijedor victims can be obtained as suggested by Bishop, Fienberg and Holland (1975; p. 241, eq. 6.4-20). All relevant formulas are included in Annex A2.1 to this report.

<sup>5</sup> The method was developed in the 1940s for estimating the size of wildlife populations. Since then it has been often used to estimate the scale of weakly measurable processes such as the prevalence of drug use, HIV infection, or prostitution. Examples of publications with applications of the capture-recapture method can be found in *Political Killings in Kosova/Kosovo. March-June 1999* (see Annex A2.1 for details).

The result of the capture-recapture method is an estimate that the actual number of those missing or killed from the municipality of Prijedor from 30.04.92 to 30.09.92 totalled 2,190 victims, with 95% confidence interval ranging from 2,115 to 2,265 individuals. Our sample of the 1,731 identified victims constitutes about 79 % of the stochastically estimated total.

## 2.2 Ethnicity, Age, and Sex and of the Victims

The total 1991 population of Prijedor municipality reported in official sources equaled 112,543, of which 56,092 individuals were men, and 56,451 were women. After eliminating duplicates (140 records were excluded), we ended with a population of 112,403 unique records of which 56,019 were men and 56,384 were women. This population was exposed to going missing and being killed by the perpetrators, in this case by Bosnian Serbs.

In this section we take the perspective of the 1991 place of residence of the victims and analyze all those victims who in 1991 lived in the municipality of Prijedor. By relating the numbers of victims originating from Prijedor to the 1991 population of Prijedor, we can produce measures of the risk of being killed or going missing for the 1991 Prijedor population<sup>6</sup>.

**Table 1. Victims from Prijedor Municipality, 30.04-30.09.92**

1991 Census Population -Adjusted	Count	Missing or Dead, 30.04-30.09.92	Count	Deaths per 100,000 1991 Population
<b>1991 Census Population -Adjusted</b>	<b>112,403</b>	<b>Missing or Dead, 30.04-30.09.92</b>	<b>1,730</b>	<b>1539.10</b>
- Non-Serbs	64948	- Non-Serbs	1,727	2659.05
- Owners, Self-Employed with Help	8335	- Owners, Self-Employed with Help	169	2027.59
- Children (0-18 years)	30803	- Children (0-18 years)	77	249.98
- Elderly (65+ years)	7735	- Elderly (65+ years)	61	788.62
- Women	56384	- Women	65	115.28

*Note: The official population size in 1991, 112,543 records, contains 140 duplicates*

Table 1 summarizes the major findings of this section. The total number of 1,731 includes 1,645 deaths of civilians and 86 of (ABH) soldiers. In relative terms (i.e. after relating it to a reference population), the overall total (1,731) is equivalent to about 1,539 deaths per 100,000 population in Prijedor in 1991. Note that the latest (1991) pre-war death rate of overall mortality in Bosnia and Herzegovina was 720 deaths per 100,000 population<sup>7</sup>. The conflict-related mortality of the Prijedor population in 30.04-30.09.92, i.e. an excess mortality that would not occur under peace, was thus equal as much as 214 % of the 1991 level. It is striking that the number of Non-Serb victims was 1,727, which was 99.83 % of all excess deaths in this period (1,731). The death rate for Non-Serbs, i.e. about 2,659 deaths per 100,000, corresponds to 369 % of the pre-war 1991 overall rate for Bosnia.

<sup>6</sup> Note that place of death is available in our sources as the place where victims were last seen (i.e. as place of disappearance), or as location of mass graves, or place of death (or disappearance) indicated to court by relatives of victims. A vast majority of places are consistently reported to be in Prijedor, or as surroundings of Prijedor.

<sup>7</sup> Statistički Godišnjak, Republike Bosne i Hercegovine, 1992. Državni Zavod za Statistiku, Sarajevo, svibanj 1994. Page 42.

The second highest loss reported in Table 1 is for owners and self-employed together with their assistance. This population group is defined on the basis of the socio-economic status (SES) of those missing or killed. It includes two upper classes of the SES structure: persons who owned a firm, shop etc. and free professions and farmers with their co-workers (i.e. families and relative of the self-employed). The death rate for owners and self-employed with their assistance equaled 2,028 per 100,000 population and constituted approximately 282 % of the 1991 mortality rate for Bosnia.

The usually most protected population groups, i.e. children, elderly and women, appeared on our lists of dead too, to a much lesser extent though than Non-Serbs or upper SES individuals. The number of children from birth to 18 years of age that died in the conflict-related circumstances in the STAKIĆ-relevant period was 77 (on average about 250 children per 100,000 population of the same age). The number of women killed or disappeared in 1992 was 65, that is about 115 per every 100,000 women living in Prijedor in 1991. There were also in total 61 deaths of those aged 65 years or more (the death rate was approximately 789 deaths per 100,000 census population of respective age). Death rates for the elderly indicate that death was very frequent among this population group, which may be related to the weak spatial mobility of the elderly who were unable to quickly move out from the conflict-affected area.

Below we discuss basic demographic distributions of the victims more specifically. Table 2 is devoted to the ethnicity of victims and Table 3 to their age distribution. Note that almost all victims reported in this section died or disappeared within the Prijedor municipality or in the close neighborhood of Prijedor. The last table in this section, Table 4, provides figures of conflict-related mortality in a larger area, to which Prijedor belonged in 1992. Table 4 makes it possible to compare the scale of mortality in Prijedor with mortality in its surroundings.

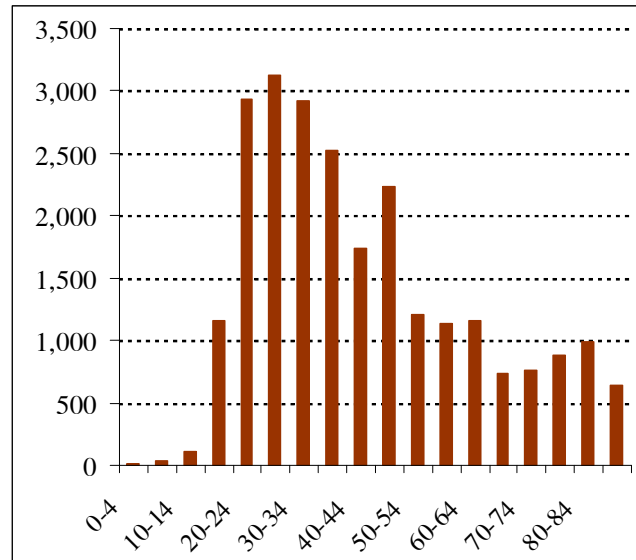
**Table 2. Victims from Prijedor Municipality, 30.04-30.09.92, by Ethnicity**

Ethnicity	Total 1991	Died 1992	Deaths per 100,000
		30.04-30.09	1991 Population
Muslims	49281	1651	3350.18
% in All	43.8	95.4	
Croats	6303	23	364.91
% in All	5.6	1.3	
Others	9364	53	566.00
% in All	8.3	3.1	
<b>Non-Serbs</b>	<b>64948</b>	<b>1727</b>	<b>2659.05</b>
<b>% in All</b>	<b>57.8</b>	<b>99.8</b>	
Serbs	47455	4	8.43
% in All	42.2	0.2	
<b>All Ethnicities</b>	<b>112403</b>	<b>1731</b>	<b>1539.99</b>

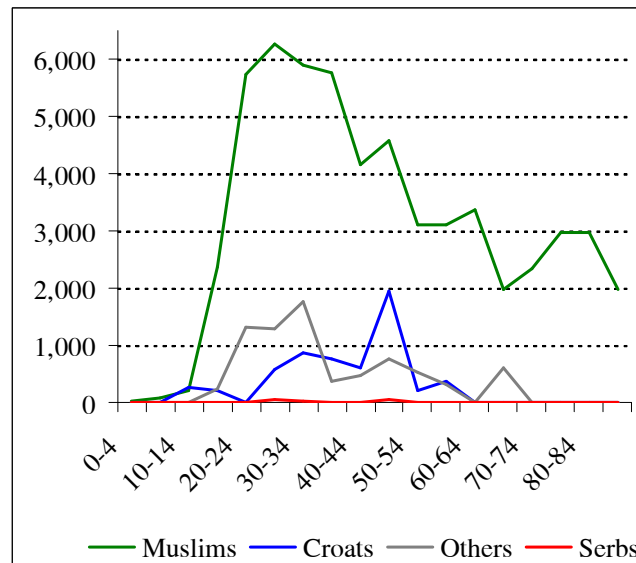
*Note: Reference population is ethnicity-specific*

Table 2 shows that most victims were of the Muslim ethnicity (1,651, about 95.4 % of all victims). Croats, Yugoslavs and remaining ethnic groups (excluding Serbs) were less frequently reported as victims (76, some 4.4 %). The mortality rate for Muslims (3,350) several times exceeded the 1991 rate of overall mortality for Bosnia and Herzegovina (720), the ratio of the two rates was 465 per cent. The rates for Croats and Others were lower and equalled 365 and 566 deaths per 100,000 relevant population (they represented 51 and 79 % of the 1991 overall rate for BH).

**Figure 2. Victims from Prijedor Municipality, 30.04-30.09.92, by Age Rates per 100,000 Census Population in Prijedor**



**Figure 3. Victims from Prijedor Municipality, 30.04-30.09.92, by Age and Ethnicity Rates per 100,000 Ethnicity-Specific Census Population in Prijedor**



Figures 2 and 3 illustrate the age distribution of the victims. In Figure 2 all ethnicities are presented jointly. Figure 3 shows the mortality age patterns of each ethnic group separately. The difference

between these two presentations is the reference population used in the calculation of rates. In Figure 1 the total (age-specific) population of Prijedor is used as reference, in Figure 2 the reference population is (age- and) ethnicity-specific. Thus, mortality of Muslims is related to the 1991 Muslim population, Serbs' mortality in relation to the 1991 Serb population and so on.

The pattern shown in Figure 2 and Table 3 allows us to distinguish four classes of death rates:

(a) death rates of children and youth: relatively low rates, especially between 0 and 14 years, clearly higher rates for the youth at age 15 to 19 years (about 1,160 deaths per 100,000), the years of life lost<sup>8</sup> are however still substantial in this sub-population,

(b) death rates of young adults: obviously the highest rates among the whole population, this class includes age groups from 20 to 49 years with the maximum seen at age 25-29 years (some 3,126 deaths per 100,000),

(c) death rates of older adults: death rates for older adults at age from 50 to 64 years are the second highest in the population and are slightly higher than 1,100 deaths per 100,000, less variation in the rates is striking,

(d) death rates of the elderly: death rates of those at age 65 years or older are approximately from 600 to 1,000 deaths per 100,000, this level is the third highest and should be considered as relatively high.

The ethnic composition of the age-specific rates (Figure 2) is consistent with the pattern shown in Table 2, thus the Muslim victims are the most frequently seen among all ethnic groups, and Non-Serb victims dramatically dominate all deaths.

Figure 3 shows the age profiles of each ethnic group separately. These ethnicity-specific patterns clearly reflect the overall age pattern discussed above for all ethnic groups jointly. Note that the rates for Muslims are extremely high, for practically all age groups from 15-19 onwards the Muslim rates are higher than 2,000 deaths per 100,000 (which is almost three times the 1991 overall death rate for Bosnia and Herzegovina). The highest rates, obtained for the age groups 20-49 years (approximately 4,000 to 6,000 deaths per 100,000) are about six to eight times higher than the overall rate for Bosnia in 1991.

Finally, it must be noted that the age patterns discussed above are all dramatically different from mortality age patterns observed in contemporary population living under peace. In such populations most deaths occur due to old age. The ageing-related increase in mortality rates develops quickly from age of approximately 40-44 years until the highest attainable age (about 124 years). Considerable numbers are also seen for infants and around age of 20-24 years (the so-called accident hump). The figures we presented for Prijedor show no similarity to the regular pattern and confirm the extraordinary character of these population losses.

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<sup>8</sup> Those who die young could have lived longer, for instance as long as the whole population lives. The life duration of a population is expressed quantitatively as the life expectancy at birth, a concept that is widely known in demography and other social sciences. The difference between someone's age at death and the life expectancy can be seen as the lost years of life. The younger the deceased the higher the difference, and the larger number of life years lost.

**Table 3. Age Distribution of Victims from Prijedor, 30.04-30.09.92**

Age 1991	Died 30.04-30.09.92		Total 1991	Deaths per 100,000
	Count	Percent		1991 Population
0-4	1	0.06	6848	14.60
5-9	3	0.17	8231	36.45
10-14	9	0.52	8214	109.57
15-19	110	6.35	9479	1160.46
20-24	284	16.41	9683	2932.98
25-29	307	17.74	9820	3126.27
30-34	263	15.19	9007	2919.95
35-39	217	12.54	8587	2527.08
40-44	124	7.16	7137	1737.42
45-49	118	6.82	5292	2229.78
50-54	88	5.08	7260	1212.12
55-59	79	4.56	6986	1130.83
60-64	66	3.81	5699	1158.10
65-69	25	1.44	3374	740.96
70-74	14	0.81	1838	761.70
75-79	11	0.64	1250	880.00
80-84	8	0.46	804	995.02
85-89	3	0.17	469	639.66
Unknown	1	0.06	2425	41.24
<b>Total</b>	<b>1731</b>	<b>100.00</b>	<b>112403</b>	<b>1539.99</b>

The last table discussed in this section is Table 4. It illustrates the 1992 victims from the Autonomous Region of Krajina (ARK) in 1992. The period covered in Table 4 is the entire year of 1992, somewhat longer than the five months from 30.04.92 to 30.09.92. Prijedor belonged geographically to ARK and the conflict in Prijedor was part of the events occurring in ARK in 1992. ARK-1992 is therefore a relevant and important context for comparisons of conflict-related mortality in Prijedor with similar mortality in other municipalities in ARK.

The victims included in Table 4 were counted from three sources: the ICRC list of missing persons (1998 edition) and exhumations and court rulings databases of OTP. Knjiga Nestalih was not used for Prijedor. Thus, the total for Prijedor is likely to be slightly higher for 1992.

In Table 4, four municipalities show exceptionally high figures: Prijedor with 1,747<sup>9</sup> deaths, Ključ (377), Sanski Most (283) and Kotor Varoš (207). If compared with the 1991 overall mortality rate for Bosnia and Herzegovina the respective ratios are as follows: Prijedor - 215.87 %, Ključ - 140.31 %, Sanski Most - 65.25 %, and Kotor Varoš - 78.18 per cent. The rate for Prijedor is the highest in the entire region of ARK. One can also see that the vast majority of victims from Prijedor went missing or got killed in the period from 30 April to 30 September 1992.

<sup>9</sup> Note that that the total for Prijedor mentioned in Table 4 is slightly higher than our total of 1,731 deaths. The records relevant to ARK covered a longer period, namely the entire year of 1992, and were obtained from different sources.

**Table 4. 1992 Victims from Prijedor Compared with 1992 Victims from ARK  
Death Rates pre 100,000 Population, By Municipality of Residence in 1991**

Municipality		Total 1991	Deaths	Deaths per 100,000 1991 Population
Banja Luka	Count	195126	16	8.20
	%	20.0	0.5	
Bihać	Count	70607	134	189.78
	%	7.2	4.5	
Bos Dubica	Count	31538	3	9.51
	%	3.2	0.1	
Bos Gradiška	Count	59907	10	16.69
	%	6.1	0.3	
Bos Krupa	Count	58227	31	53.24
	%	6.0	1.0	
Bos Novi	Count	41609	63	151.41
	%	4.3	2.1	
Bos Petrovac	Count	15586	20	128.32
	%	1.6	0.7	
Čelinac	Count	18669	7	37.50
	%	1.9	0.2	
Donji Vakuf	Count	24533	28	114.13
	%	2.5	0.9	
Jajce	Count	44974	29	64.48
	%	4.6	1.0	
Ključ	Count	37317	377	1010.26
	%	3.8	12.5	
Kotor Varoš	Count	36774	207	562.90
	%	3.8	6.9	
Mrkonjić Grad	Count	27332	4	14.63
	%	2.8	0.1	
Prijedor	Count	112403	1747	1554.23
	%	11.5	58.0	
Prnjavor	Count	46994	1	2.13
	%	4.8	0.0	
Sanski Most	Count	60238	283	469.80
	%	6.2	9.4	
Skender Vakuf	Count	19345	4	20.68
	%	2.0	0.1	
Šipovo	Count	15535	1	6.44
	%	1.6	0.0	
Teslić	Count	59766	45	75.29
	%	6.1	1.5	
Total	Count	976480	3010	308.25
	%	100	100	

### 3. Educational Attainment, Occupational Activity and Ethnicity of Missing and Killed Persons from Prijedor 30.04-30.09.92

This section discusses the statistical relationship between the socio-economic status of the Prijedor population (hereafter: SES) and their risk of going missing or being killed (hereafter: MISSING) during the period 30.04-30.09.92 . The socio-economic status was measured by using two variables: educational attainment (hereafter EDU) and occupational status (hereafter OCCU), both obtained from the 1991 census questionnaire. Below, for each SES variable we firstly show the empirical fraction of those missing and killed in the 1991 population of Prijedor municipality. This allows us to identify certain SES patterns among missing and killed persons. Secondly, we verify these patterns by estimating relative risks of going missing or being killed, and their respective significance levels, for SES variables and all ethnic groups. Logistic regression models are used as the statistical tool of estimation.

The census question underlying the operationalisation of educational attainment was related to the number of school years completed by the respondent. The census interviewers assigned responses to this question into one of 10 possible answers mentioned in the questionnaire. Later we re-coded the original responses into the following categories: (1) no education at all, (2) incomplete elementary school, (3) elementary school, (4) middle school (i.e. secondary education), (5) higher or university education (i.e. post-secondary), (6) in school (i.e. continuing education), and (7) missing values. The categories (6) and (7) were excluded from the analysis.

Occupational status was defined on the basis of two census questions combined in one variable. The questions were the following:

- occupational activity (ZAN: active vs. various categories of inactive; question answered by all respondents)
- occupational position (PZAN: employees vs. owners, self-employed, and their aid; question answered only by those professionally active)

The variable made of the two above-mentioned questions is a measure of occupational status of those professionally active as well as those inactive. It allowed us to classify the population among the following five categories: (1) inactive, (2) employees, (3) owners of a firm or a private store or shop, (4) self-employed persons (including farmers) working on their own or with assistance of other household members, (5) household members giving assistance to (i.e. helping) self-employed. The variable OCCU was obtained by combining all original responses on PZAN, with one common code of being inactive taken from ZAN<sup>10</sup>.

The missing/killed persons studied, were those listed in the ICRC List of Missing Persons, version 4 1998, *Knjiga Nestalih* of Prijedor, and OTP Exhumations and Court Rulings Databases. In all analyses only the persons matched with the 1991 census were analysed. All persons included in the analyses were required to be 18 or more years of age, which was dictated by the need of excluding those who were still taking education in 1991 and those not yet allowed to work.

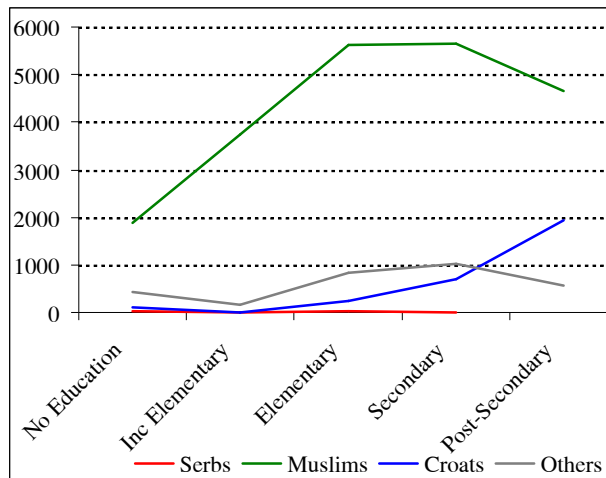
In the municipality of Prijedor there were in total 1,666 men and 65 women, who went missing or got killed from 30 April to 30 September 1992. The 1991 population of Prijedor consisted of 56,019 valid

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<sup>10</sup> A number of persons who reported themselves as inactive also indicated themselves as being active, especially housekeepers, pupils or students made this type of double statement of occupational activity. For such persons we took their response on PZAN as superior to that on ZAN. In other words, we coded them as active and neglected their inactivity.

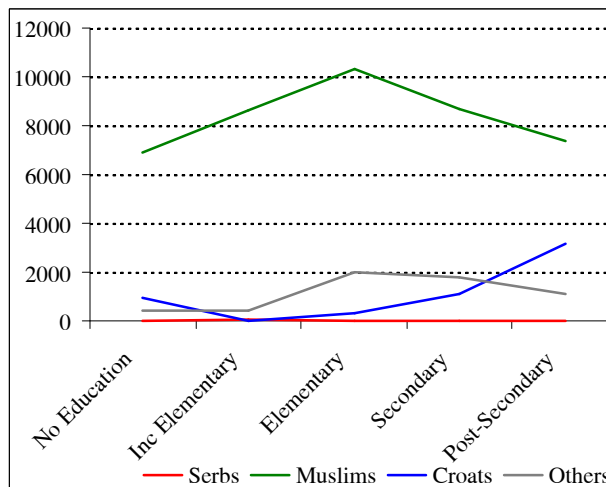
records<sup>11</sup> for men and 56,384 for women. As mentioned before, the age of the population has been restricted to those at age 18 or more years. This restriction ensured that persons attending schools and those too young to work were excluded from the analysis. Some persons aged 18 years or more were found who still continued education but the number of these persons was low and could be neglected. The total 18+ population of Prijedor municipality amounted to 83,518 individuals, of which 41,361 were men and 42,157 were women in 1991.

**Figure 4a. Rates of Missing/Killed Persons from Prijedor, 30.04-30.09.92  
By Ethnicity and Education (age 18+)**



*Note: Rates express Missing/Deaths per 100,000 1991 Population 18+*

**Figure 4b. Rates of Missing/Killed Men from Prijedor, 30.04-30.09.92  
By Ethnicity and Education (age 18+)**



*Note: Rates express Missing/Deaths per 100,000 1991 Population 18+*

<sup>11</sup> The numbers quoted exclude duplicates. Generally, a valid record is the one that is complete in terms of information needed for a particular analysis. If for instance ethnicity is not available for a person, such a person cannot be included in the analysis where ethnicity is studied. Thus, the total number of valid records is not necessarily identical in all types of analysis and can be different from the same total available from official sources.

**Table 5a. Missing/Killed Persons from Prijedor, 30.04-30.09.92  
By Ethnicity and Education (age 18+)**

Variable	Ethnicity	No Education	Incomplete Elementary	Elementary	Secondary	Post-Secondary	Unknown	Total
Died 18+	Serbs	0	2	0	2	0	0	4
	Muslims	94	258	496	695	57	9	1609
	Croats	1	0	3	12	5	0	21
	Others	2	1	10	34	4	1	52
	Total	97	261	509	743	66	10	1686
1991 Population 18+	Serbs	6406	6852	7695	13253	2142	591	36939
	Muslims	4977	6886	8816	12301	1226	731	34937
	Croats	839	949	1199	1725	258	53	5023
	Others	463	577	1193	3308	692	386	6619
	Total	12685	15264	18903	30587	4318	1761	83518
Deaths per 100,000 Population	Serbs	0	29	0	15	0	0	11
	Muslims	1889	3747	5626	5650	4649	1231	4605
	Croats	119	0	250	696	1938	0	418
	Others	432	173	838	1028	578	259	786
	Total	765	1710	2693	2429	1528	568	2019

**Table 5b. Missing/Killed Men from Prijedor, 30.04-30.09.92  
By Ethnicity and Education (age 18+)**

Variable	Ethnicity	No Education	Incomplete Elementary	Elementary	Secondary	Post-Secondary	Unknown	Total
Died 18+	Serbs	0	2	0	2	0	0	4
	Muslims	74	240	488	687	56	9	1554
	Croats	1	0	2	12	5	0	20
	Others	1	1	10	31	4	1	48
	Total	76	243	500	732	65	10	1626
1991 Population 18+	Serbs	1173	3104	4206	8045	1357	310	18195
	Muslims	1075	2780	4719	7889	760	354	17577
	Croats	104	381	600	1067	159	23	2334
	Others	224	237	499	1729	364	202	3255
	Total	2576	6502	10024	18730	2640	889	41361
Deaths per 100,000 Population	Serbs	0	64	0	25	0	0	22
	Muslims	6884	8633	10341	8708	7368	2542	8841
	Croats	962	0	333	1125	3145	0	857
	Others	446	422	2004	1793	1099	495	1475
	Total	2950	3737	4988	3908	2462	1125	3931

The number of missing/killed persons at age 18+ equalled respectively 1,626 men and 20 women. It is obvious that the Prijedor male population of missing persons can be studied with most credibility.

An indicator characterising the missing/killed persons population in relative terms is the rate of missing/killed persons in the 1991 census population (after dividing by 1,000, the rate becomes a proportion of missing/killed in the 1991 population). Figure 4a shows the education-specific rate by ethnicity for men and women jointly, Figure 4b shows the same rates for men only.

The proportions of missing Muslims (men and women) from Prijedor have clearly elevated levels on the education categories 3 (elementary), 4 (secondary) and 5 (post-secondary), see Figure 4a and Table 5a. The respective proportions are approximately 5.6, 5.7 and 4.6 per cent. Persons with “no education” or “incomplete elementary education” are characterised by lower levels of the risk of missing/killed. One more finding of the same type is that Croats from Prijedor show higher proportions of missing/killed on the three upper categories of the education attainment (elementary EDU: 0.3%, secondary EDU: 0.7%, and post-secondary EDU: 1.9%). Also Others from Prijedor show

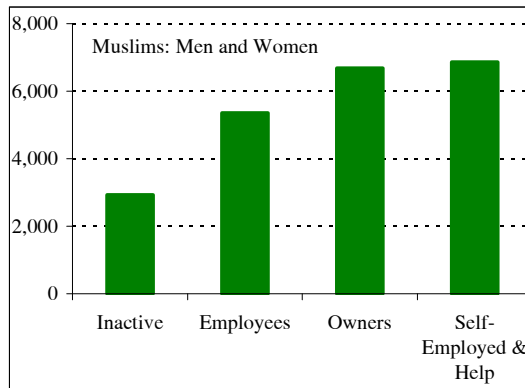
a similar pattern of increased levels in the proportion of missing/killed associated with higher classes of the educational attainment (elementary EDU: 0.8%, secondary EDU: 1.0%, post-secondary EDU: 0.6%). The fractions for Croats and Others are clearly lower than the fractions for Muslims.

Summing up, persons with secondary or post-secondary level of education, especially Muslims, have higher risks of missing/killed than persons with lower education. However, also those with elementary education are characterised by relatively high risks of missing/killed. In addition to that, persons with the highest education do not always show the highest risks of missing/killed. The results obtained for men confirm the findings discussed above for both sexes jointly.

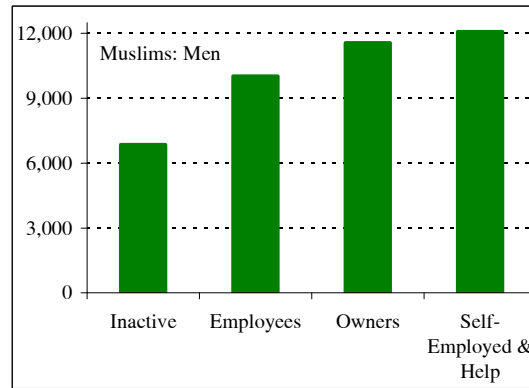
Thus, the pattern found in our list of missing/killed does not consistently indicate the existence of education-related targeting of the Prijedor population.

The second SES variable studied here is the occupational status of the victims (see Figure 5 and Tables 6a and 6b below).

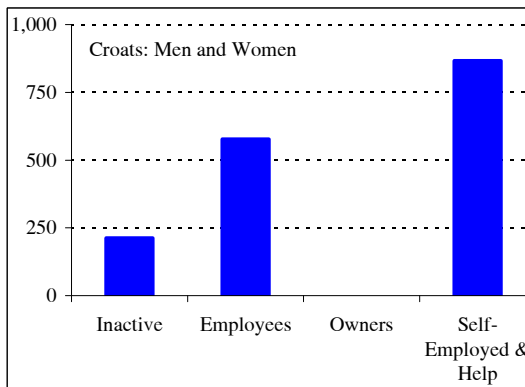
**Figure 5. Rates of Missing and Killed Persons from Prijedor, 30.04-30.09.92  
Age 18+, By Occupational Status**



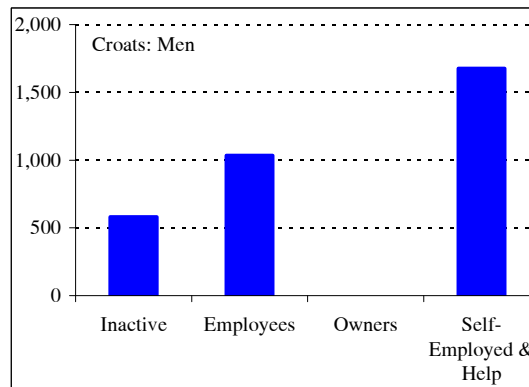
*Note: Deaths per 100,000 1991 Population 18+*



*Note: Deaths per 100,000 1991 Population 18+*



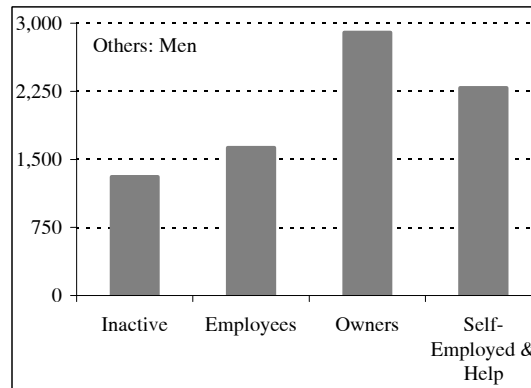
*Note: Deaths per 100,000 1991 Population 18+*



*Note: Deaths per 100,000 1991 Population 18+*



Note: Deaths per 100,000 1991 Population 18+



Note: Deaths per 100,000 1991 Population 18+

It is unquestionable that for all Non-Serbs two uppermost categories on the occupational status, i.e. owners and self-employed with their aid, consistently show the highest risks of missing/killed. Two lower categories, inactive and employees, consistently have lowest risks of missing/death. It is also clear that a systematic increase in the risk of missing/killed is associated with the socio-economic gradient in occupational status. The risks for Muslims are the highest among all three Non-Serb ethnic groups. The results for men indicate basically the same pattern, their risks are considerably higher though, due to the fact that the vast majority of victims from Prijedor were men.

**Table 6a. Missing and Killed Persons from Prijedor, 30.04-30.09.92  
Age 18+, By Occupational Status**

Variable	Ethnicity	Inactive	Employees	Owners	Self-Employed	Help to Self Employed	Unknown	Total
Died 18+	Serbs	0	4	0	0	0	0	4
	Muslims	268	1114	32	110	13	72	1609
	Croats	4	14	0	3	0	0	21
	Others	11	33	2	3	1	2	52
	Total	283	1165	34	116	14	74	1686
1991 Population 18+	Serbs	10019	21395	372	2741	177	2235	36939
	Muslims	9133	20786	479	1657	136	2746	34937
	Croats	1875	2426	38	316	30	338	5023
	Others	1516	4023	144	218	16	702	6619
	Total	22543	48630	1033	4932	359	6021	83518
Deaths per 100,000 Population	Serbs	0	19	0	0	0	0	11
	Muslims	2934	5359	6681	6639	9559	2622	4605
	Croats	213	577	0	949	0	0	418
	Others	726	820	1389	1376	6250	285	786
	Total	1255	2396	3291	2352	3900	1229	2019

**Table 6b. Missing and Killed Men from Prijedor, 30.04-30.09.92  
Age 18+, By Occupational Status**

Variable	Ethnicity	Inactive	Employees	Owners	Self-Employed	Help to Self Employed	Unknown	Total
Died 18+	Serbs	0	4	0	0	0	0	4
	Muslims	250	1082	31	107	13	71	1554
	Croats	4	13	0	3	0	0	20
	Others	10	31	2	2	1	2	48
	Total	264	1130	33	112	14	73	1626
1991 Population 18+	Serbs	3801	11294	210	1407	62	1421	18195
	Muslims	3648	10796	268	943	50	1872	17577
	Croats	689	1257	20	167	12	189	2334
	Others	765	1904	69	124	7	386	3255
	Total	8903	25251	567	2641	131	3868	41361
Deaths per 100,000 Population	Serbs	0	35	0	0	0	0	22
	Muslims	6853	10022	11567	11347	26000	3793	8841
	Croats	581	1034	0	1796	0	0	857
	Others	1307	1628	2899	1613	14286	518	1475
	Total	2965	4475	5820	4241	10687	1887	3931

In order to test the significance of the empirical patterns discussed above, we estimated a logistic regression models that made it possible to us measure relative risks of going missing or being killed, and significance levels of these risks, by occupational status. The model was formulated for the risk of missing/killed, ethnicity and occupational status.

Logistic regression allows us to estimate the risks of missing/killed and the differences in these risks by ethnicity and SES variables (Hutcheson and Sofroniou, 1999; see also Annex). The estimation usually takes the risk for one pre-selected population group, such as for instance Others, occupationally “inactive”, as the reference.

Several logistic regression models have been estimated in this study, but only the interaction effects models are taken for the discussion below (Figure 6, Table 7). These models are essential for showing the joint effect of belonging to a particular ethnic group and having a particular category of occupational status at the same time.

The  $\exp(\beta)$  parameters are the interaction effects of ethnicity and occupational status with respect to the odds of being missing/killed versus non-missing/non-killed and taking occupationally inactive Others as the reference group.

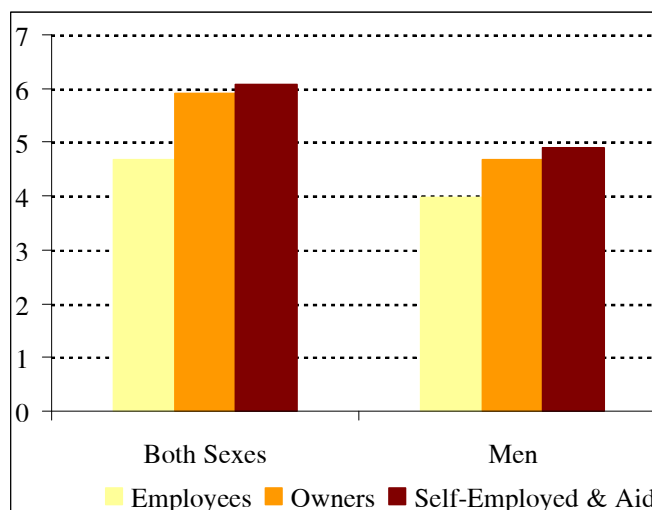
For Muslims from Prijedor all effects (i.e.  $\exp(\beta)$ ) are statistically significant. For Croats, only the effect for employees is significant. Generally, we can therefore speak about a statistically significant pattern of targeting obtained for Muslims whose risk, as shown in Table 7 and Figure 6, are all several times higher than the risk for the reference category of inactive Others. Moreover the risks for Muslims clearly increase as one moves up the occupational status. This finding is clear for both sexes together and also for men.

The odds of missing to non-missing occupationally inactive Others were approximately 0.0121 (about 12 missing/killed inactive Others per 1000 non-missing inactive Others). Muslim employees had the  $\exp(\beta)$  value of about 4.7, meaning that the odds for Muslim employees were 4.7 times higher than the odds for inactive Others. In other words, Muslim employees had the risk of going missing 4.7 times higher than inactive Others. Moreover, for Muslims aged 18+ from Prijedor, the estimated

relative risk of missing/killed (i.e.  $\exp(\beta)$ ) increased with the occupational status from about 4.7 to 6.1.

For Croats, only the effects for employees are significant, the effects for those with higher occupational status are statistically insignificant. The effects for Croats are lower than 1 indicating that the risks for Others are higher than those for Croats. Nevertheless, the self-employed and their aid have the highest risks among all occupational categories.

**Figure 6. Relative Risks of Missing/Killed for Muslims from Prijedor, 30.04-30.09.92  
In Reference to Occupationally Inactive Others**



**Table 7. Relative Risks of Missing/Killed for Muslims from Prijedor, 30.04-30.09.92  
In Reference to Occupationally Inactive Others**

Ethnicity	SES Position	Men and Women		Men	
		Significance	Exp(B)	Significance	Exp(B)
Croats	Employees	0.0073	0.4799	0.0005	0.3730
Croats	Owners	0.8280	0.0031	0.8568	0.0013
Croats	Self_Employed & Help	0.5779	0.7231	0.3957	0.6084
Muslims	Employees	0.0000	4.6819	0.0000	3.9754
Muslims	Owners	0.0000	5.9187	0.0000	4.6683
Muslims	Self_Employed & Help	0.0000	6.0894	0.0000	4.9058
Serbs	Employees	0.0000	0.0158	0.0000	0.0127
Serbs	Owners	0.4968	0.0031	0.5587	0.0013
Serbs	Self_Employed & Help	0.0570	0.0031	0.1220	0.0013
Constant		0.0000	0.0121	0.0000	0.0280

To summarise the results discussed in this section, the following can be stated:

- Muslims (especially men) were targeted in Prijedor much more intensively than other Non-Serbs. The risks of missing/killed estimated for Muslims by occupational status were all significant and the highest among all ethnic groups.
- Those Muslims who were owners of a firm or a shop etc. or who were self-employed were targeted most of all, especially Muslim men.
- For all Non-Serbs the estimated risks of going missing were clearly higher for those from upper occupational classes, and to a lesser extent for those with higher (but not always the highest) educational categories. The pattern related to occupational status is extremely obvious. The one related to education is less clear.
- Croats and Others were targeted too and their risks of going missing were consistently the highest for owners and self-employed with aid and for those with secondary and post-secondary education. The risks for Croats and Others were considerably lower than the risks for Muslims.

## **ANNEX**

- **A1. SOURCES USED FOR THIS REPORT**
- **A2. STATISTICAL FOUNDATION FOR THE ANALYSIS**

## **A1. SOURCES USED FOR THIS REPORT**

### **A1.1 THE ICRC LIST OF MISSING PERSONS**

Since 1991, the International Committee of the Red Cross (ICRC) has collected data on persons reported as missing from the Former Yugoslavia, including Prijedor, in order “... *to help families establish the fate of their relatives who remain missing.*”<sup>12</sup> The organisation collected data primarily from close family members and occasionally accepted reports from more distant relatives and from friends and neighbours. They registered persons known to be dead but whose bodies have not been found. ICRC published a separate list of persons known to be dead (generally previously registered as missing)<sup>13</sup>.

ICRC published several versions (i.e. up-dates) of their list of missing persons from Bosnia and Herzegovina. In June 1998, they issued the latest 4<sup>th</sup> version of the Book of the Missing (about 19,000 names), and in October 2000 an addendum to the 4<sup>th</sup> edition with additional 1,000 names collected between June 1998 and October 2000. For the analyses presented in this report, the 4<sup>th</sup> version of the Book of Missing, released in June 1998, was used.

Till the year 2000, the ICRC has received requests to trace a total of 20,508 persons who disappeared in the conflict in Bosnia and Herzegovina<sup>14</sup>. Out of this total, some 1,949 persons were identified dead following exhumations, 860 missing persons were declared dead but their mortal remains were not recovered, and some 292 were found alive. The families of 17,407 missing persons have still received no confirmation of the fate of their relatives. It is generally assumed, however, that most (if not all) of those people are dead. The ICRC itself also expressed this opinion<sup>15</sup>.

### **A1.2 KNIJGA NESTALIH FROM PRIJEDOR (BOOK OF DISAPPEARED)**

The Association of Prijedor, located in Sanski Most, has compiled this book of persons who went missing from the Prijedor municipality. It includes persons’ names, date of birth, place and date of disappearance and a photograph if available. In total the 1998 edition of this book contained 3,146 records. The quality of these records is varying.

### **A1.3 THE EXHUMATIONS DATABASE**

This database (hereafter EXH) has been established at OTP by Nicolas Sébire (2001) on the basis of the extensive documentation received by ICTY from the parties involved in the exhumations in ARK. The documentation was prepared during the exhumations by either the Bosnian authorities or the forensic team and archaeologists from the International Criminal Tribunal for the former Yugoslavia.

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<sup>12</sup> From the introduction to “*Missing persons on the territory of Bosnia and Herzegovina*”, Fourth edition issued on 30.06.1998 – by alphabetical order, International Committee of the Red Cross. Place of publication not given (probably Sarajevo).

<sup>13</sup> Death has been established based on eyewitness accounts and/or evidence provided by the family.

<sup>14</sup> ICRC Report on “Persons Unaccounted for in BiH”. Sarajevo, October-November 2000

The essential part of the documentation is a general exhumation report drawn up by the examining judge. The report consists of a general description of the exhumation site, the exhumation itself, the number of bodies exhumed and, in most cases, provides a description of the forensic results of the autopsies. Where known, the report states the identity of the exhumed bodies and information about the circumstances and date of death.

The identification of the exhumed bodies was conducted by the Bosnian Police using witness interview reports. The interviews made it possible to establish the circumstances of death or disappearance of an individual and also the date the person died (or at least the year).

The ICTY documentation consisted of several reports, including the summary reports by the chief archaeologist and chief forensic scientist, and the reports on the DNA analyses performed to identify the bodies.

Examples of variables included in the Exhumations Database are the following: municipality, exhumation site, exhumation date, number of bodies exhumed at the site, family name of the exhumed individual (LNU standing for “last name unknown”), the first name of the individual exhumed (FNU standing for “first name unknown”), date of birth of the exhumed individual (with place of birth if known), date of death of the exhumed individual, that is, either the exact date of death, the month and the year, or just the year. In many cases, this information has not been inputted.

The Exhumations Database that has been used for analysis presented in this report is dated on 23 November 2000.

#### **A1.4 THE PROOF OF DEATH DATABASE**

Nicolas Sébire has established this database (hereafter CR; Sébire, 2001) on the basis of judgements (i.e. court rulings, CR) issued in the past years by two municipal courts, the Sanski Most and Ključ municipal courts, officially declaring individuals dead. The judgements were rendered at the request of a member of the missing person’s family and relied on the testimony of the applicant or, in some cases, of witnesses able to testify to the date and circumstances surrounding the disappearance or death.

The documentation relates to a population of 1,668<sup>16</sup> individuals from the municipalities of Prijedor, Sanski Most, Banja Luka, Bosanski Novi, Bosanska Dubica, Ključ and Kotor Varoš, who were killed or went missing. A list was compiled according to municipality showing persons who in the most cases died or went missing in 1992 (1,465 victims died in 1992, and 203 victims in other periods). The lists are not exhaustive since this sort of judgement is only issued at the request of a member of the missing person’s family. Requests of this kind can be made to any municipal court in Bosnia-Herzegovina provided that the applicant resides within its jurisdiction. The Court Rulings Database that has been discussed in this report is dated on 13 March 2001.

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<sup>15</sup> See ICRC’s special report on “The issue of missing persons from Bosnia and Herzegovina, Croatia and the Federal Republic of Yugoslavia”, published in February 1998.

<sup>16</sup> Originally, there were 1,672 records in this database. Four duplicates were found and excluded, which brought the total down to 1,668 individuals.

## A2. STATISTICAL FOUNDATION FOR THE ANALYSIS

### A2.1 CAPTURE-RECAPTURE METHOD

The capture – recapture method was originally proposed for estimating the unknown size of animal populations. Since then it has been then adopted by many other research disciplines. In this annex we present the rationale of this method and explain how we used it in our study.

The capture – recapture method is applied when we deal with a population of unknown size and our task is to estimate the total number of members of this population. We do this in two steps. First, we randomly select a sample from this population, mark all captured individuals, put them back to the original population and allow them to mix up with the rest of the population. Every individual should have the same probability of being captured as the others. In the second step we select a next random sample. The two samples should be drawn independently. Thus, the probability that an individual is re-captured in sample 2 has nothing to do with the fact, whether or not it was captured and marked in sample 1. From the mathematical point of view the independence of two events means, that the probability of occurring two events jointly is equal to the probability of occurrence of the first event multiplied by the probability of occurrence of the second event. We can write it that way:

$$P(A \cap B) = P(A) \cdot P(B).$$

Having selected the second sample, we count the re-captured individuals in it. Note that the “re-captured” individuals are those of all captured in sample 2 who previously were also captured (and marked) in sample 1. The underlying principle of the capture – recapture method is that the share of re-captured individuals in sample 2 estimates the share of captured (and marked) individuals from sample 1 in the whole population. Because the number of marked individuals in the whole population is known (from step 1) and also the estimated share of the marked individuals in the population is known (from step 2), we can calculate the total number of individuals in the population. We do this by dividing the number of marked individuals by their estimated share in the population.

If  $M$  denotes the total number of individuals in the population,  $p$  is the estimated share of all marked individuals in the population (i.e. the share of re-captured individuals in the second sample), and  $M_A$  is the number of individuals marked in step 1 (i.e. those captured in sample 1), we obtain<sup>17</sup>:

$$\hat{M} = \frac{M_A}{p}. \quad (1)$$

If  $M_B$  is the number of individuals in the second sample and  $M_{AB}$  for the number of re-captured individuals from the second sample (i.e. those also captured and marked in the first sample) we get, that:

$$p = \frac{M_{AB}}{M_B}. \quad (2)$$

The estimated total size of the population can be therefore also expressed as:

$$\hat{M} = \frac{M_A M_B}{M_{AB}}. \quad (3)$$

Or as:  $\hat{M} = M_{11} + M_{01} + M_{10} + M_{00}$ , where  $M_{00} = \frac{M_{10}M_{01}}{M_{11}}$  is the unreported part of M, whereas

$M_{11}$  is the overlap of the two samples,  $M_{10}$  is the number of individuals only in sample 1, and  $M_{01}$  the number of those only in sample 2.

All this reasoning makes sense if the samples are large as is the overlap between both samples (i.e. the number of re-captured individuals in the second sample)<sup>18</sup>.

Our objective was to estimate the total number of persons from Prijedor who went missing or got killed during the given period of time (30.04-30.09.92). We had three samples at our disposal, the ICRC List of Missing Persons (ICRC), *Knjiga Nestalih* (KN) of Prijedor, and Exhumations and Court Rulings Databases (EXH). The sources were large and there existed a significant overlap between them. We considered the ICRC list as the first sample and all records from this source as captured and marked. The two remaining sources (KN and EXH) were considered the second and third samples. We then counted the “re-captured” records in KN and EXH databases. This means that we measured the overlap of the three sources. Under the realistic assumption that all sources were created independently<sup>19</sup>, we recalled that the share of “re-captured” records in the KN and EXH databases is the same as the share of “captured” records (from ICRC) in the whole population and applied Equation 4 (a modification of Equation 3) to obtain the total number of killed persons.

SOURCES' OVERLAP	Symbol	No. of Persons
ICRC Missing Persons <i>only</i>	$M_{001}$	433
<i>Knjiga Nestalih only</i>	$M_{010}$	397
Exhumations <i>only</i>	$M_{100}$	0
ICRC and <i>Knjiga Nestalih</i>	$M_{011}$	263
ICRC and Exhumations	$M_{101}$	210
<i>Knjiga Nestalih</i> and Exhumations	$M_{110}$	271
ICRC, <i>Knjiga Nestalih</i> , and Exhumations	$M_{111}$	157
ALL SOURCES TOGETHER		1,731

Where three data sources are analysed, one being quasi-independent from the other two (in our case the ICRC List of Missing Persons, being the source with data systematically collected during the war), the number of victims not included in three mentioned sources ( $M_{000}$ ) can be estimated by the following equation (Bishop, Fienberg and Holland, *Discrete Multivariate Analysis: Theory and Practice*, Cambridge, Mass.: MIT Press, 1975, equations 6.4-20, p. 241):

<sup>17</sup> A hat above  $M$  means that it is an estimated value.

<sup>18</sup> What is “large” or “small” is quite subjective, but we will not discuss this issue, for our samples are approximately 1,000 records, which is definitely not small.

$$\hat{M}_{000} = M_{001} \cdot \frac{M_{110} + M_{100} + M_{010}}{M_{111} + M_{101} + M_{011}} = 459 \quad (4)$$

Thus, the total number of victims  $N$ , can be estimated by:

$$\hat{M} = M + \hat{M}_{000} = 1,731 + 459 = 2,190$$

Standard error of estimation can be obtained from the following equation:

$$SE(\hat{N}) = SE(\hat{M}_{000}) = \sqrt{\hat{M}_{000}^2 \cdot \left( \frac{1}{M_{110} + M_{100} + M_{010} + M_{000}} + \frac{1}{M_{111} + M_{101} + M_{011}} + \frac{1}{M_{001}} + \frac{1}{\hat{M}_{000}} \right)} =$$

38.3

When the sample is large (more than 120 observations, as in our case) the  $(1-\alpha) \cdot 100\%$  confidence interval for the total number of victims  $N$  is based on the normal distribution, ranging from  $\hat{N} - SE(\hat{N}) \cdot u_\alpha$  to  $\hat{N} + SE(\hat{N}) \cdot u_\alpha$ , where  $u_\alpha$  denotes the  $\alpha$ -rank quantile from the normal distribution. In our case, the 95% confidence interval is relatively narrow, ranging from 2,115 to 2,265.

#### Sources:

Y. Bishop, Fienberg and Holland, Discrete Multivariate Analysis: Theory and Practice, Cambridge, Mass.: MIT Press, 1975,

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Capture-Recapture Webpage: <http://www.pitt.edu>

## A2.2 LOGISTIC REGRESSION MODEL: THEORY

The logistic regression model is

$$\frac{P(y=1)}{P(y=0)} = \exp(b_0 + b_1x_1 + \dots + b_nx_n) + err$$

The dependent (or response) variable  $\frac{P(y=1)}{P(y=0)}$  is the ratio of the probability of going missing ( $y=1$ )

divided by the probability of not going missing ( $y=0$ ). The ratio is called the odds.

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<sup>19</sup> The independence of sources means that the fact, that a record is reported in ICRC list, does not change the chance of being included in KN and EXH databases, and *vice-versa*.

The  $x_1, x_2$  etc. are the categories of the explanatory variables. The  $b_0, b_1$  etc are the coefficients (or model parameters). The coefficient  $b_i$  gives the change in log odds of  $y=1$  (the event occurring) for a unit change in  $x_i$ , holding all other explanatory variables constant. Equivalently,  $\exp(b_i)$ , the exponential of the coefficient, shows the change in the odds of  $y=1$  for a unit change in  $x_i$ . The *err* is the error term.

Logistic regression does not make any assumptions about the underlying distribution of the response variable. Logistic regression is appropriate for binary response variables when the distribution of the attribute of interest lies between about 0.05 and 0.95 of the sample.

Logistic regression does not calculate  $R^2$ , which is the usually used measure of goodness of fit. For logistic regression the likelihood  $L$  is used to assess the probability of the sample of data occurring under the model. The likelihood is the product of the probabilities for each case:

$$L = \prod_{j=1}^n P_j(\hat{y} = y_i)$$

The higher the likelihood, the more likely it is that the sample has occurred under the given model, i.e. the better the fit of the model. The coefficients are estimated to maximise the likelihood.

As the likelihood is a product of probabilities, its maximum value is 1 (perfect fit). In practice, it has a small, hard to compare value, and hence a function of the likelihood is used instead:  $-2 \log(\text{likelihood})$  (or  $-2LL$ ). The smaller the value of the  $-2LL$ , the better the model. A perfect model will have a  $-2LL$  of 0).

Source: G. Hutcheson, N. Sofroniou, (1999), *The Multivariate Social Scientist. Introductory Statistics Using Generalized Linear Models*. SAGE Publications. London, Thousand Oaks, New Delhi.

### A2.3 LOGISTIC REGRESSION: PRACTICAL REMARKS

The logistic regression model explains the variation in the so-called dependent variable by the variation in a number of independent explanatory variables. In our study the dependent variable is the ratio of the probability of missing/killed to that of non-missing/non-killed persons. The ratio is called odds. The explanatory variables are ethnicity, occupational status, and a variable measuring the joint impact (or interaction) of ethnicity and occupational status. Next to the explanatory variables the model includes several parameters (called effects) and a constant. Parameters are specified for each category of the independent variables. For the variable “ethnicity”, four parameters need to be included: one for Serbs, one for Muslims, one for Croats, and one for Others. Likewise, the number of effects for “occupational status” is four: “occupationally inactive” effect, “employees” effect, “owners” effect, “self-employed and aid to self-employed” effect. The number of interaction effects is 16 (combinations of all categories of ethnicity and occupational position). During the estimation one of the effects for each particular variable is eliminated (otherwise the model cannot be estimated; for ethnicity Others can be eliminated, for occupational status those “inactive”, and for interactions all combinations of Others and “inactive” category). The eliminated effects indicate a reference category (e.g. Others who were occupationally inactive) that is used in estimating the remaining components of the model. In fact, all model parameters (except of the constant) are obtained as relative indicators (i.e. in relation to the reference category). The constant is just the effect for the reference group.

The most complex regression model separates the effects of belonging to a particular ethnic group (main effects of ethnicity), from those of having a particular occupational status (main effects of occupational position), and of being a member of an ethnic group and having a certain occupational status at the same time (the interaction effects of ethnicity and occupational status). Simpler models include the main effects of ethnicity and occupational status, or interaction effects only. Any of these models can be used to show occupation-related differences in the risk of missing/killed among the ethnic groups, importantly the estimates of these risks are obtained from a joint estimation and better characterise the process of going missing than any parametric test of significance for single proportions.