

Good Fences:

The Importance of Setting Boundaries for Peaceful Coexistence

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Abstract

We consider the conditions of peace and violence among ethnic groups, testing a theory designed to predict the locations of violence and interventions that can promote peace. Characterizing the model's success in predicting peace requires examples where peace prevails despite diversity. Switzerland is recognized as a country of peace, stability and prosperity. This is surprising because of its linguistic and religious diversity that in other parts of the world lead to conflict and violence. Here we analyze how peaceful stability is maintained. Our analysis shows that peace does not depend on integrated coexistence, but rather on well defined topographical and political boundaries separating groups. Mountains and lakes are an important part of the boundaries between sharply defined linguistic areas. Political canton and circle (sub-canton) boundaries often separate religious groups. Where such boundaries do not appear to be sufficient, we find that specific aspects of the population distribution either guarantee sufficient separation or sufficient mixing to inhibit intergroup violence according to the quantitative theory of conflict. In exactly one region, a porous mountain range does not adequately separate linguistic groups and violent conflict has led to the recent creation of the canton of Jura. Our analysis supports the hypothesis that violence between groups can be inhibited by physical and political boundaries. A similar analysis of the area of the former Yugoslavia shows that during widespread ethnic violence existing political boundaries did not coincide with the boundaries of distinct groups, but peace prevailed in specific areas where they did coincide. The success of peace in Switzerland may serve as a model to resolve conflict in other ethnically diverse countries and regions of the world.

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Achieving peace requires a vision of what it looks like. How we imagine peace affects the steps we take and our ability to implement it in diverse locations around the world. Does peace in one place look the same as in another? Is knowledge of the specifics of each conflict necessary to negotiate peace between ethnic groups in conflict? Even if specifics are important, there are broad frameworks that guide our thinking. Recently, we introduced a complex systems theory of ethnic conflict that describes the conflicts in areas of the former Yugoslavia and India with high accuracy [1]. In this theory, specific details of history, social and economic conditions are not the primary conditions for peace or conflict. Instead the geographic arrangement of populations is key. Significantly, it points to two distinct conditions that are conducive to peace—well mixed and well separated. The first corresponds to the most commonly striven for framework of an integrated society [2]. The second corresponds to spatial separation, partition and self determination—a historically used but often reviled approach [3]. Here we consider a more subtle third approach, that of within-state boundaries in which cooperation and separation are both necessary. The success of this approach is of particular importance as the world becomes more connected. As illustrated by the European Union, the role of borders as boundaries is changing.

In order to evaluate the role of within-state boundaries in peace, we considered the coexistence of groups in Switzerland. Switzerland is known as a country of great stability, without major internal conflict despite multiple languages and religions [4,5]. Switzerland is not a well-mixed society, it is heterogeneous geographically in both language and religion (Fig. 1). The alpine topography and the federal system of strong cantons have been noted as being relevant to coexistence; their importance can be seen in Napoleon’s statement, after the failure of his centralized Helvetic Republic, that “nature” had made Switzerland a federation [6–8]. But the existence of both alpine and non-alpine boundaries between groups and the presence of multiple languages and religions within individual cantons suggest partition is not essential for peaceful coexistence in Switzerland. In identifying the causes of peace, the literature has focused on socio-economic and political conditions including a long tradition of mediation and accommodation, social cleavages that “cross-cut” the population rather than coincide with each other, unwritten and written rights of proportionality (fairness) and cultural protectionism, a federal system with strong sub-national units, a civil society that fosters unity, direct democracy through frequent referenda, small size, historical time difference between cleavage in language and religion, neutrality in international warfare, and

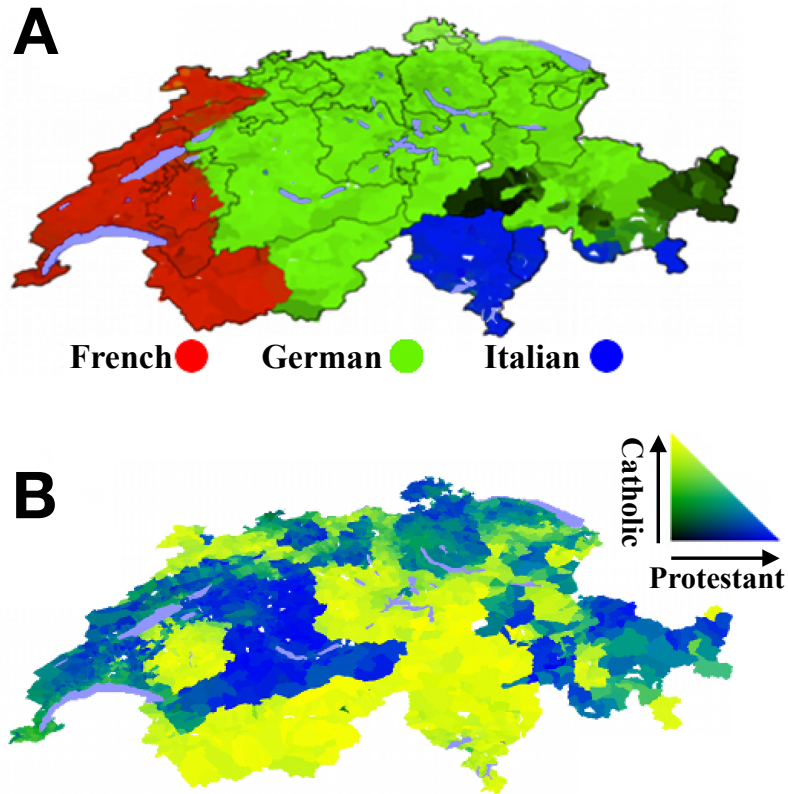


FIG. 1: Maps of Switzerland showing the 2000 census proportion of (A) linguistic groups, (B) Catholic and Protestant (Mercator projection).

economic prosperity [4–6,9–13]. Geography plays an unclear, presumably supporting, role in these frameworks. The analysis of coexistence in Switzerland is also part of a broader debate about whether social and geographical aspects of federalism promote peace or conflict [15].

In this paper we analyze the geographical distribution of groups in Switzerland based solely upon the hypothesis that spatial patterns formed by ethnic groups are predictive of unrest and violence among them [1]. The theory asserts that highly mixed regions or well-segregated groups are peaceful, while groups of a certain intermediate geographical size are likely to engage in violence. While effective separation may be achieved when group areas are large enough, the model also allows that topographic or political boundaries may serve as separations to promote peace [1,16]. Using the case of Switzerland, we test the ability of the theory to predict peaceful coexistence in the context of internal country boundaries. Where explicit boundaries do not exist, such as in mixed cantons where alpine boundaries

are absent, violence might be expected, and the results of the model in these areas serve as a particularly stringent test of the theory. In most cases violence is not predicted, consistent with what is found. In one area a significant level of violence is predicted, and violence is actually observed. The analysis sheds light on the example of Switzerland as a model for peaceful coexistence. The former Yugoslavia serves as a contrasting example of widespread violence. The theory correctly identifies areas of conflict and areas of peace also in the former Yugoslavia. The precision of the results provides some assurance of the usefulness of the theory in planning interventions that might promote peace in many areas of the world.

The geographical distribution theory [1] considers type separation into geographical domains independent of the specification of the individual types—a universality of type behavior in collective violence. Violence arises due to the structure of boundaries between groups rather than as a result of inherent conflicts between the groups themselves. In this approach, diverse social and economic causal factors trigger violence when the spatial population structure creates a propensity to conflict, so that spatial heterogeneity itself is predictive of local violence. The local ethnic patch size serves as an “order parameter,” a measure of the degree of order of collective action, to which other aspects of behavior are coupled. The importance of collective behavior implies that ethnic violence can be studied in the universal context of collective dynamics, where models can identify how individual and collective behavior are related.

The analysis is applicable to communal violence and not to criminal activity or interstate warfare. In highly mixed regions, groups of the same type are not large enough to develop strong collective identities, or to identify public spaces as associated with one or another cultural group. They are neither imposed upon nor impose upon other groups, and are not perceived as a threat to the cultural values or social/political self-determination of other groups. Partial separation with poorly defined boundaries fosters conflict. Violence arises when groups are of a geographical size that they are able to impose cultural norms on public spaces, but where there are still intermittent violations of these rules due to the overlap of cultural domains. When groups are larger than the critical size, they typically form self-sufficient entities that enjoy local sovereignty. Hence, we expect violence to arise when groups of a certain characteristic size are formed, and not when groups are much smaller or larger than this size. The model of violence depends on the distribution of the population and not on the specific mechanism by which the population achieves this structure, which may include

internally or externally directed migrations. By focusing on the geographic distribution of the population, the model seeks a predictor of conflict that can easily be determined by census. This may work well because geography is an important aspect of the dimensions of social space, and other aspects of social behavior (e.g., isolationism, conformity, as well as violence) are correlated to it.

Physical boundaries such as mountain ranges and lakes or national and subnational political boundaries that establish local autonomy may prevent the violations of cultural norms and enable self-determination, inhibiting the triggers of violence. By creating autonomous domains of activity and authority, the boundaries shield groups of the characteristic size from each other when they correspond with their geographical domains.

Mathematically, evaluation of the model begins by mapping census data onto a spatial grid. We included the fraction of every population type on each site. The expected violence is determined by detecting patches consisting of islands or peninsulas of one type surrounded by populations of other types. These features are detected by pattern recognition using the correlation of the population for each population type with a template that has a positive center and a negative surround. The template used is based on a wavelet filter [1,17,18]. Wavelets are designed to obtain a local measure of the degree to which a certain scale of variation (wavelength) is present. Outcomes are highly robust, and other templates give similar results. The diameter of the positive region of the wavelet, i.e., the size of the local population patches that are likely to experience violence, is the only essential parameter of the model. The parameter is to be determined by agreement of the model with reports of violence, and results were robust to varying the parameter across a wide range of values. To model the effect of boundaries, we assume that separate autonomous regions can be analyzed by including only the populations within each of the autonomous areas to determine the expected violence. Where boundaries are incomplete, as might be the case for mountains, lakes and convoluted political boundaries, we include only the populations that are in line of sight through gaps or past ends of boundaries to determine the expected violence within a region. An effective map of populations at each site is constructed, determined by the orientation of any boundaries relative to that site. Populations past boundaries of the line of sight are replaced by neutral populations. The result of the correlation of population with the wavelet filter is a single value at every location, the theoretical “propensity to violence,” and the locations of expected violence are obtained by applying a threshold to that value.

The location of groups of a certain size is indicative of a violence-prone group, but the precise location of violence is not determined. The proximity of these violence-prone groups to actual violence is tested by constructing proximity maps. The proximity to reported violence is correlated to the proximity to violence prone groups. The model was validated without boundaries [1] by applying it to the former Yugoslavia, yielding correlations of up to 0.89. The results were robust to varying the characteristic length between 18–60 km. Our revised method with fractional population values on every site gave similar results with correlations of up to 0.87. (Methods are further described in the Appendix.)

We now consider the linguistic (Fig. 2) and religious (Fig. 3) groups in Switzerland, each in turn. Initial analyses and the sequence of historical boundary formation suggested considering topographical barriers when discussing language groups, and political barriers when considering religious groups. The geography of languages primarily reflects the extent of invasions prior to the existence of current political boundaries and has remained stable in most areas for over a thousand years [5]. The modern state was established afterwards, and religious conflict played a role in establishing the internal political boundaries [5–7]. Census data were obtained for 2634 municipalities (communes) in Switzerland (bfs.admin.ch), yielding a high spatial resolution.

Language and topographical barriers - We study the three main language groups—German, French and Italian (Fig. 3A)—which together comprise 91% of the total population in the 2000 census (Romansh, the fourth official language, accounts for less than 2%). We considered only the effect of physical boundaries due to lakes and mountain ranges (Fig. 3, B and C). We determined the presence of topographical boundaries using an edge detection algorithm on topographical heights (Fig. 3D). This process identifies where there is a sharp change in height, i.e., a cliff, or steep incline, that runs for a significant distance forming a natural boundary. Elevation data with a spatial resolution of approximately 91m [19] was coarsened to pixels of size 9.1×9.1 km. Edges were identified where there was an increase of more than 1.8 km in height over a distance of 9.1 km (11.5°) using a discretized Laplacian differential operator [20] with a mask size of a single pixel. The conclusions are robust to variations in the elevation angle (Appendix). Calculations of the propensity to violence are reported here (Fig. 3, E and F) for the characteristic length of 24 km and in the Appendix for a range of characteristic lengths. Without boundaries, the correlation of the wavelet filter

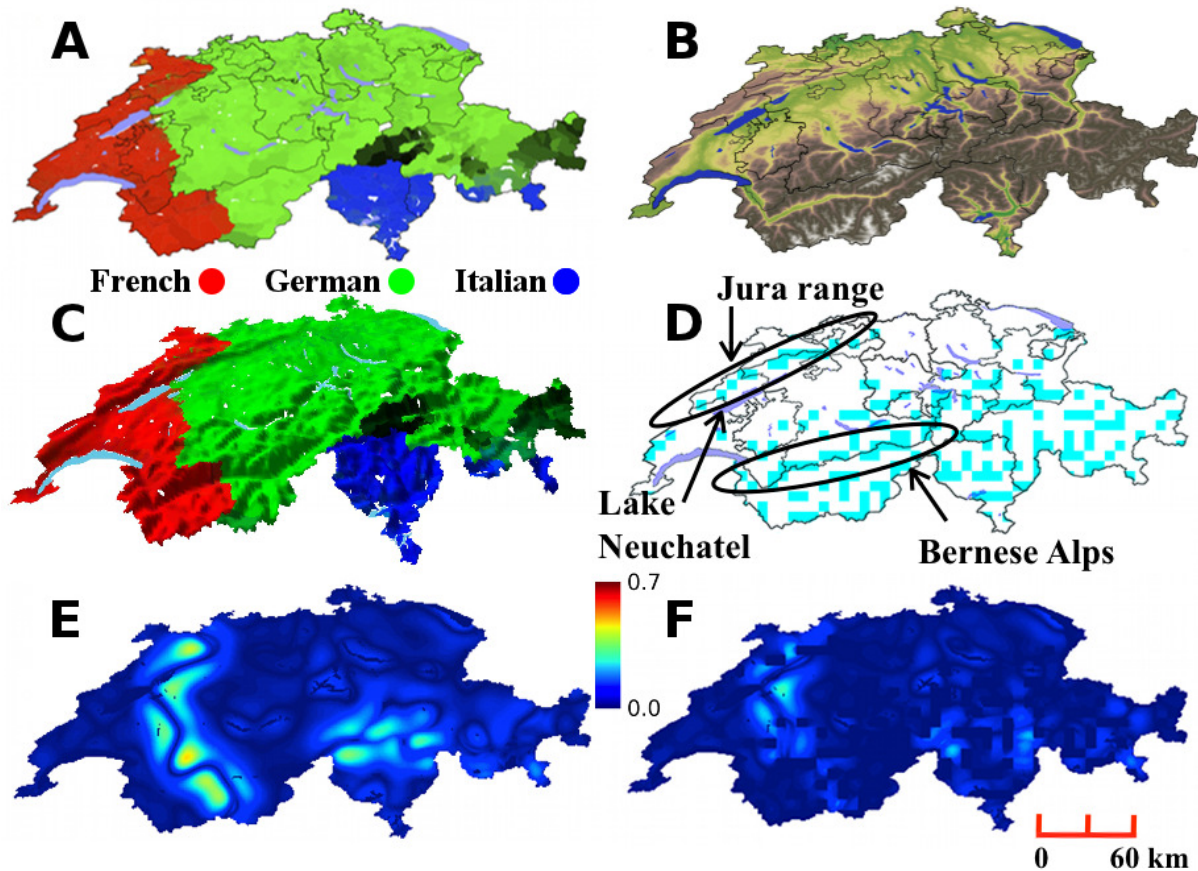


FIG. 2: Maps of Switzerland showing (A) proportion of linguistic groups according to the 2000 census, (B) elevation within Switzerland, (C) overlay of linguistic groups onto a digital elevation model, and (D) topographical features including lakes (blue) and ridges extracted using edge detection (cyan). Comparison of calculated propensity (color bar) to violence between linguistic groups without (E) and with (F) the inclusion of topographical features as boundaries using a characteristic length scale of 24 km. Mercator projection, except C which is the Europe Albers projection. The distance scale is approximate.

yields a maximum propensity to violence value of 0.48. With topographical boundaries the maximum propensity is reduced to 0.30. Between the German and French-speaking areas to the northwest, the Jura mountain range and Lake Neuchatel, and to the south, the Bernese Alps, are mitigating boundaries. The interface between Lake Neuchatel and the Bernese Alps through the canton of Fribourg has no mitigating boundary, but is almost straight—neither side is surrounded by the other, so the propensity is low. Between the Italian and German-speaking areas, the Lepontine Alps dramatically reduce the calculated propensity.

The Jura range is, however, a porous boundary, and the highest residual propensity is adjacent to it in the northwest of the canton of Bern, which, unique in Switzerland, is historically known to be an area of “intense” linguistically-based conflict, including arson, bombings and other terrorist tactics [13,21]. We obtained a correlation higher than 0.95 between predicted and reported violence (Appendix), consistent with the hypothesis of the model. Manifesting Swiss willingness to create political boundaries, the conflict led to a referendum, and in 1978 the modern-day canton of Jura was created out of part of the north of what was then the canton of Bern [7]. While the conflict underlying the unrest was linguistic, local votes led to separation by majority religion. However, conflict did not end, and a proposal to shift the French-speaking Protestant areas of Bern to join French-speaking Catholic Jura is currently being considered [22]. Our results suggest that a calculated propensity to violence of 0.3 should be considered just at the threshold for actual violence, even under the social and political conditions prevailing in Switzerland. Remarkably, at this threshold high correlations (above 0.8) also are found in the former Yugoslavia. Thus, similar propensities for violence in different social contexts result in violence.

Religious Groups and Political Barriers - The two main religious groups of Switzerland are Protestant and Catholic. The Swiss federal political system separates the country into 26 “cantons” and “half-cantons” considered as semi-autonomous political units (Fig. 3). Moreover, this schema is repeated within the largest canton by area, Graubünden, whose sub-cantonal divisions called circles (*kreise*) have a distinctive political autonomy [4,12]. We obtained canton boundaries from mapping resources (www.gadm.org, www.toposhop.admin.ch). Circles boundaries were identified by district lists (www.gis.gr.ch). In the 2000 census, Roman Catholic and Protestant affiliations account for 77% of the total population. Less than 8% subscribe to other religions, and the remainder have no religious affiliation or did not specify one. Without boundaries, the maximum calculated propensity to violence is very high (0.57), and with political borders it is only 0.20. Without Graubünden circles, the propensity increases to a quite high 0.42, still well above the threshold. Because of a 10% decline in religious affiliation in recent years, we considered also the 1990 census, with similar conclusions (Appendix).

The separation of religions by canton is apparent geographically and historically. In some cases the area of a canton includes small enclaves embedded in another canton whose

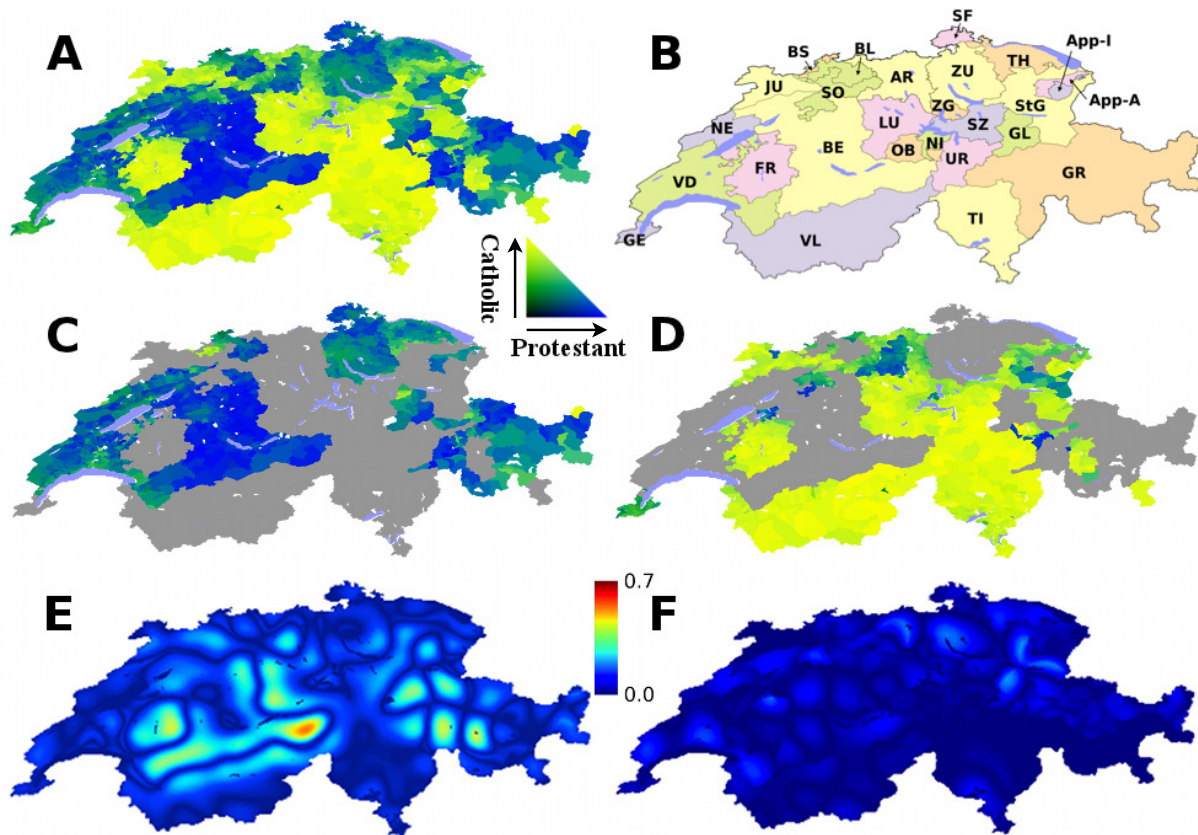


FIG. 3: Maps of Switzerland (Mercator projection) showing (A) proportion of Catholic (yellow) and Protestant (blue) according to the 2000 census, (B) cantons, (C) and (D) cantons (and Graubünden circles) that are majority Protestant and Catholic respectively, using the same color map as A. Comparison of propensity to violence between religious groups without (E) and with (F) the inclusion of administrative boundaries using a characteristic length scale of 24 km. Propensity value scale is shown by color bar. Canton abbreviations are GE: Genève, SO: Solothurn, ZG: Zug, VL: Valais, BS: Basel-Stadt, GL: Glarus, VD: Vaud, BL: Basel-Landschaft, TI: Ticino, NE: Neuchatel, AR: Aargau, GR: Graubünden, FR: Fribourg, LU: Lucerne, App-A: Appenzell-Ausserhoden, BE: Bern, OB: Obwalden, App-I: Appenzell-Innerrhoden, JU: Jura, NI: Nidwalden, StG: St. Gallen, UR: Uri, SF: Schaffhausen, TH: Thurgau, SZ: Schwyz, ZU: Zurich.

majority religion corresponds to the canton to which they belong. Still, there are exceptions to the separation of religions by canton. In each case the geography is sufficient to limit the propensity to violence. For example, there is an area of Protestant majority in the far north of the Catholic canton of Fribourg. It is, however on a long appendage and therefore

is not surrounded by Catholic areas, and so has a low propensity to violence according to the analysis. Historical evidence is found in conflict in the 1500s [7]. The Reformation led to cantons adopting a Protestant or retaining a Catholic identity. A brief war resulted in a peace treaty that established religious freedom by canton. The canton Appenzell was split by religious differences into two “half-cantons” Innerrhoden and Ausserrhoden. The political independence of circles (*kreise*) in Graubünden also provided religious autonomy [12]. The intentional formation of political boundaries in regions that would have violence according to the model, and the subsequent model propensity below the threshold associated to a lack of actual violence are consistent with the hypothesis on the role of boundaries in peaceful coexistence.

Yugoslavia - Our modified method including boundaries was tested on the previous case study of Yugoslavia, consisting of the combined area of Croatia, Bosnia, Serbia and Montenegro. Topographical boundaries reduce the maximum propensity from 0.63 to 0.57, and administrative borders to 0.56. The correlations of predicted and reported violence changes were insignificantly lower, with correlations of 0.86 and 0.85, respectively. That political boundaries do not have a greater impact on the calculated violence implies that they do not align with the geographical boundaries between groups. We also extended the area to include Macedonia and Slovenia, parts of the Socialist Federal Republic of Yugoslavia before gaining independence (Fig. 4). With the political boundaries the correlation is still 0.85; however, when political boundaries are not included, the correlation is reduced considerably to 0.72. The lower correlation is specifically due to a high calculated propensity to violence along the borders of Slovenia with Croatia, and of Macedonia with Serbia and Kosovo. These areas, however, were peaceful—consistent with the predictions when boundaries are included. Our results suggest that these political borders were instrumental in reducing ethnic violence, whereas the violence in other areas of Yugoslavia was not prevented because of poor alignment of borders with population groups.

This work is part of a broader effort to use new methods for quantitative analysis of patterns of violence and their prevention [23–31]. There is also interest in ethnic group interactions across national borders [32–34]. We have shown that groups that are not well-mixed but are geographically separated by natural or political boundaries into autonomous domains are peaceful in both Switzerland and the former Yugoslavia. Our work clarifies

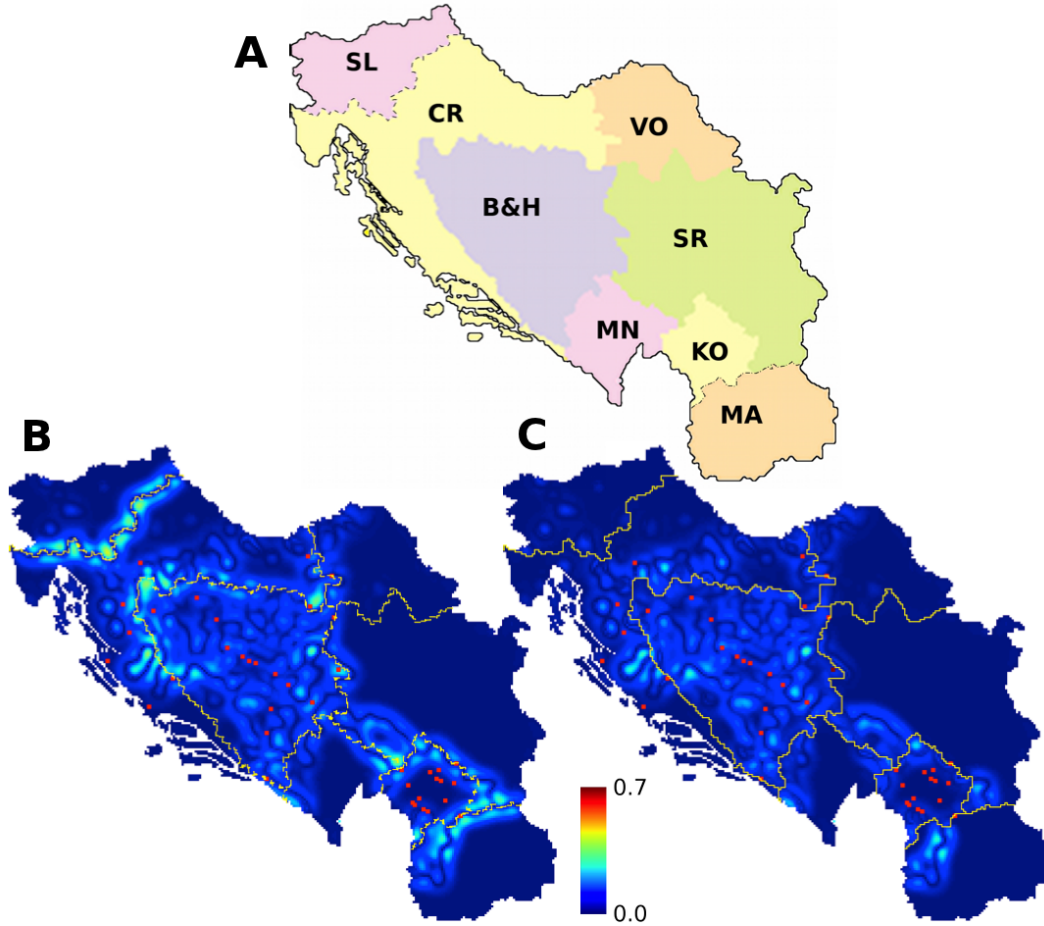


FIG. 4: (A) Map of the area of the former Yugoslavia showing administrative provinces. Propensity to violence calculated without (B) and with (C) administrative boundaries, using a characteristic length of 21 km. Locations of boundaries are shown on both plots as solid and dashed yellow lines respectively. Sites of reported violence are shown as red dots [18]. Spurious violence is predicted along the borders of Slovenia and Macedonia when boundaries are not included. Province labels are: SL: Slovenia, CR: Croatia, VO: Vojvodina*, B&H: Bosnia & Herzegovina, SR: Serbia, MN: Montenegro, KO: Kosovo*, MA: Macedonia. (*Autonomous administrative provinces of Serbia.)

the ambiguities of mixed language and religion Swiss cantons by showing that in most cases the natural geography of the populations conspires to lead to a low level of violence, so that additional boundaries were not necessary; where they were needed, as in Graubünden, they were established. The highest calculated propensity to violence is between linguistic groups in the northern part of the canton of Bern, where historically unresolved real world

tensions actually exist. Our analysis indicates that both administrative and natural barriers can play a significant role in mitigating conflict between religious and linguistic groups. Historical evidence suggests that for religious groups the boundaries in Switzerland were created to provide autonomy to a group with a shared identity and avoid conflict among multiple groups. Ongoing efforts to reduce tensions in Bern include introducing new political boundaries. The many political, social and economic factors that play roles in reducing violence [4–6,9–14] build on a strong foundation of geographical borders. Our analysis suggests that when partition within a country is viewed as an acceptable form of conflict mitigation, such partition can give rise to highly stable coexistence and peace.

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