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# Disappeared persons and homicide in El Salvador

Carlos Carcach\*  and Evelyn Artola

## Abstract

During 2012–2013, the homicide rate in El Salvador came down from 69.9 to 42.2 per 100,000 population following a government brokered truce between the leaders of the two major gangs, *Mara Salvatrucha* and *Barrio 18*. But despite the apparent successes of the truce, it was speculated that the drop in murders could have been due to the killers simply hid the bodies of their victims. This paper aims at determining whether gangs effectively disappeared their victims to cut down the official counts of murders, or they committed these crimes for other reasons. The results from this study suggest that Salvadoran gangs had been using disappearance as a method to gain sustained social control among residents of already gang-dominated areas, that together with homicide, disappearance is part of a process of territorial spread and strategic strengthening by which these groups are enhancing their capabilities to interfere in the alliances of Mexican drug trafficking organizations with Central American criminal organizations specializing in the trans-shipment of drugs and in providing access to local markets to distribute and sell drugs. Our findings show that the risk for disappearance has been large even before the truce was in place and that actually, it continues as such and going through a process of geographic expansion.

**Keywords:** El Salvador, *Maras*, Bayesian mapping, Trends in disappearance, Homicide trends, Bayesian shared component model

## *Maras* and violence in El Salvador

El Salvador, together with Guatemala and Honduras, is part of the so called Northern Triangle of Central America, arguably the most violent region in the world. The country is affected by a strong *mara* presence and is part of the drug trafficking corridor linking South America to the United States. In this paper, the terms *mara* and gang are used interchangeably to refer to both the *Mara Salvatrucha* and *Barrio 18*, either *Sureños* or *Revolucionarios*.

Unlike other street gangs, the *maras* are hierarchical organizations that coordinate their criminal activities across the United States, Mexico and Central America; fight against the authorities and against each other, for control of turf and local distribution of drugs; and use violence both against rivals and within their own groups to maintain internal order (Bruneau 2011).

Despite the widespread of *maras* in El Salvador, there is not an agreed figure, either official or otherwise, on the number of individuals belonging to or related to these groups. Over the years, estimates of the number of gangs and gang members have varied depending on the source. For instance and according to the National Civilian Police, there were 10,500 active gang members in 2005, but the extinct National Council of Public Safety counted approximately 39,000 (Kinnear 2009). In 2015, an estimated 55,000 persons were gang members, with an estimated 470,000 affiliated with the gangs, including family members, friends and helpers, organized in 560 *clicas* nationwide (Ellis 2015).

These groups are held responsible for at least 60% of all homicides committed in El Salvador (Wolf 2011) but also are involved, inter alia, in extortion, kidnapping, rape, and the local distribution of drugs. In recent years, *maras* have evolved into complex criminal organizations associated with the drug trafficking transport networks tied to Mexican cartels, and are in possession of “assault rifles, vehicles, safe houses, encrypted satellite phones and are

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even able to deploy drones to monitor the movements of police or rival gangs”. *Maras* “enforce curfews, man roadblocks to control access to their neighborhoods, and decide who can sell or move drugs and where. The *maras* have become more like political military forces than street gangs” (Farah 2016).

In March 2012, the government brokered a truce between the Salvadorian *maras* during which the homicide rate dropped by half. However, it has been alleged that under the truce, the *maras* hid the large numbers of people still being killed by burying them in clandestine cemeteries. Forcible displacement and forced migration are other phenomena that have also been attributed to *maras* and criminal organizations such as drug transporters and cartels as well (Farah 2012; Stone 2012, 2013; Sánchez-Aiscorbe 2014; Cantor 2014; Ellis 2015).

National survey data show at least 12,600 and 29,400 disappearances in 2012 and 2014, respectively. The number of persons forced to change their place of residence due to threats increased from at least 29,500 in 2012 to 64,400 in 2014 (IUDOP 2012, 2015). According to Salvadorian authorities, a significant number of disappearances are related to gang activity, since many of the missing were in gangs, or friends or relatives of gang members (US Department of State 2016).

The role that organized crime groups, *maras* included, might play in generating these events is little-studied. In El Salvador, a link between disappearances and homicides remains a distinct possibility. One may consider these phenomena as arising from unobserved common sources. Though there are no reliable data on the attribution of both these crimes, media and official reports suggest that at least under the truce, the *maras* may have perpetrated most of the disappearances recorded by the Salvadorian authorities (Farah 2012; Ellis 2015).

Models of spatial variation in crime rates and other crime related outcomes use location as a surrogate for the mix of routine activities, environmental clues and conditions, and opportunity structures that may underlie geographic differences in risk. As many crimes share common risk factors, analyzing their joint spatial behavior may help in obtaining more evidence of real clustering in the risk surface than would be available from the analysis of a single type of crime.

This research investigates the hypothesis that both homicide and disappearance are outcomes from unobserved processes associated to a greater extent with geographic variations of *mara* related activities. We expect that a significant between-municipality variation in relative risk of disappearance be explained by its joint spatial variation with homicide through a common cause, namely *maras*. A Bayesian approach is implemented to account for the uncertainty due to the fact that the data

cannot fully inform whether this expected strong correlation between homicides and disappearances is due to gang activity.

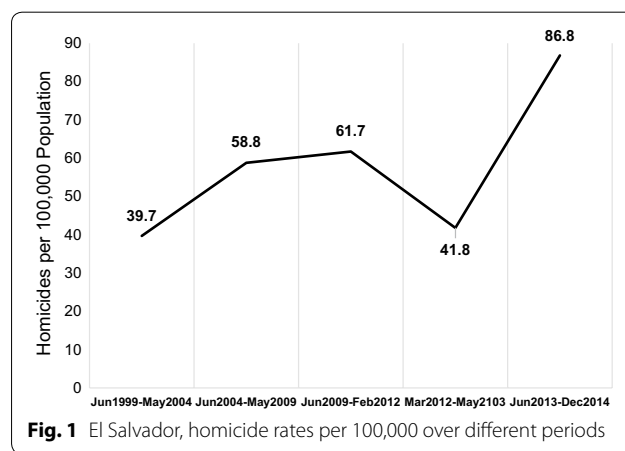
This paper contributes to the discussion of patterns of gang violence in Central America, particularly in El Salvador. It explores the joint spatio-temporal behavior of homicides and disappearances over 2010–2014, a period covering March 2012–April 2013, the 14 months under the gang truce.

The paper continues with a review of homicide rates showing their decline during the early truce, followed by a discussion on how forced disappearances explain this dip and how those relate to *maras*. Then, we review and analyze the data on forced disappearances using an unobserved component model. Presentation and discussion of results precede the conclusion. References and acknowledgements are included at the end of the paper.

### Pre-truce and post-truce homicide rates

Figure 1 shows homicide rates computed over 4 consecutive government periods. The first running from June 1999 to May 2004, recorded 39.7 homicides per 100,000 population and was scenery to the so called “Strong Hand Plan” that was implemented in 2003 under President Francisco Flores with the main objective of breaking up of gangs. It contemplated joint actions by the national police (PNC) and the army. The rate increased to 58.8 over June 2004–May 2009 in which the newly elected government of President Antonio Saca implemented what they named as “Ultra Strong Hand” policy, a set of actions aimed at fighting gangs, drug trafficking and money laundering.

The homicide rate went up to 61.7 murders per 100,000 during the first half of the government period of President Mauricio Funes, June 2009–February 2012. From March 2012 to May 2013, the two major gangs, the *Mara Salvatrucha* and *Barrio 18*, negotiated a 15 month truce, allegedly facilitated by the government at the behest of



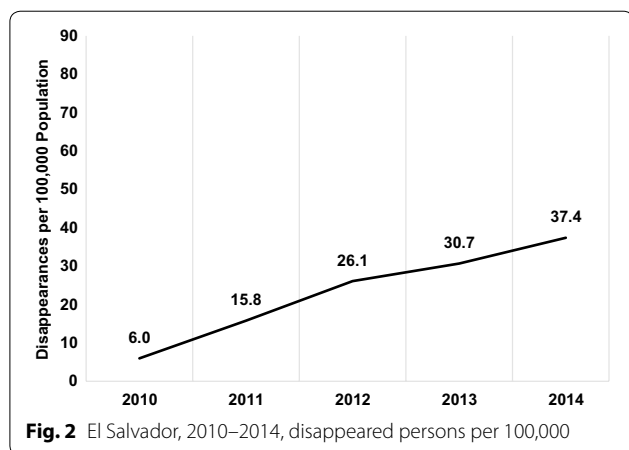
local drug traffickers and supported by the Organization of American States, under which the homicide rate fell down to 41.8. The truce aimed at reducing the numbers of murders in exchange for granting concessions to incarcerated gang leaders. The *maras* used the truce, particularly the MS-13, “to rearm, reorganize, build closer ties to regional cocaine transport networks, develop a political and economic strategy, and evolve from street gangs to criminal organizations with territorial and political control” (Farah 2016).

During the following 18 months, from June 2013 to December 2014, following the sitting of President Salvador Sánchez Cerén, who backed off from the truce and adopted a strategy based on a frontal combat to gangs, the homicide rate more than doubled to reach 86.8 per 100,000 residents.

### Disappearances and homicides

The possibility that the decline in recorded homicide under the gang truce might have been accompanied by increases in the numbers of disappearances has been sustained by both the media and local crime and safety experts (Savenije and Van der Borgh 2014; Rivera Virúes 2014). In early 2014, the *Instituto de Medicina Legal* reported that during the truce, the number of disappeared had risen by an almost identical amount to the decline in the number of homicides. There is a strong belief that gangs used disappearances to bring homicide counts artificially down. Figure 2 shows police recorded cases of missing or disappeared persons per 100,000 population during each of the 5 years from 2010 to 2014. The rate went up from 6.0 in 2010 to 37.4 in 2014. In particular, it increased from 15.8 in 2011 to 26.1 in 2012 and to 30.7 in 2013 (i.e. the years when the gang truce was in place).

Figure 3 shows relative risks or standardized rates for both homicides and disappearances across municipalities and over time periods.



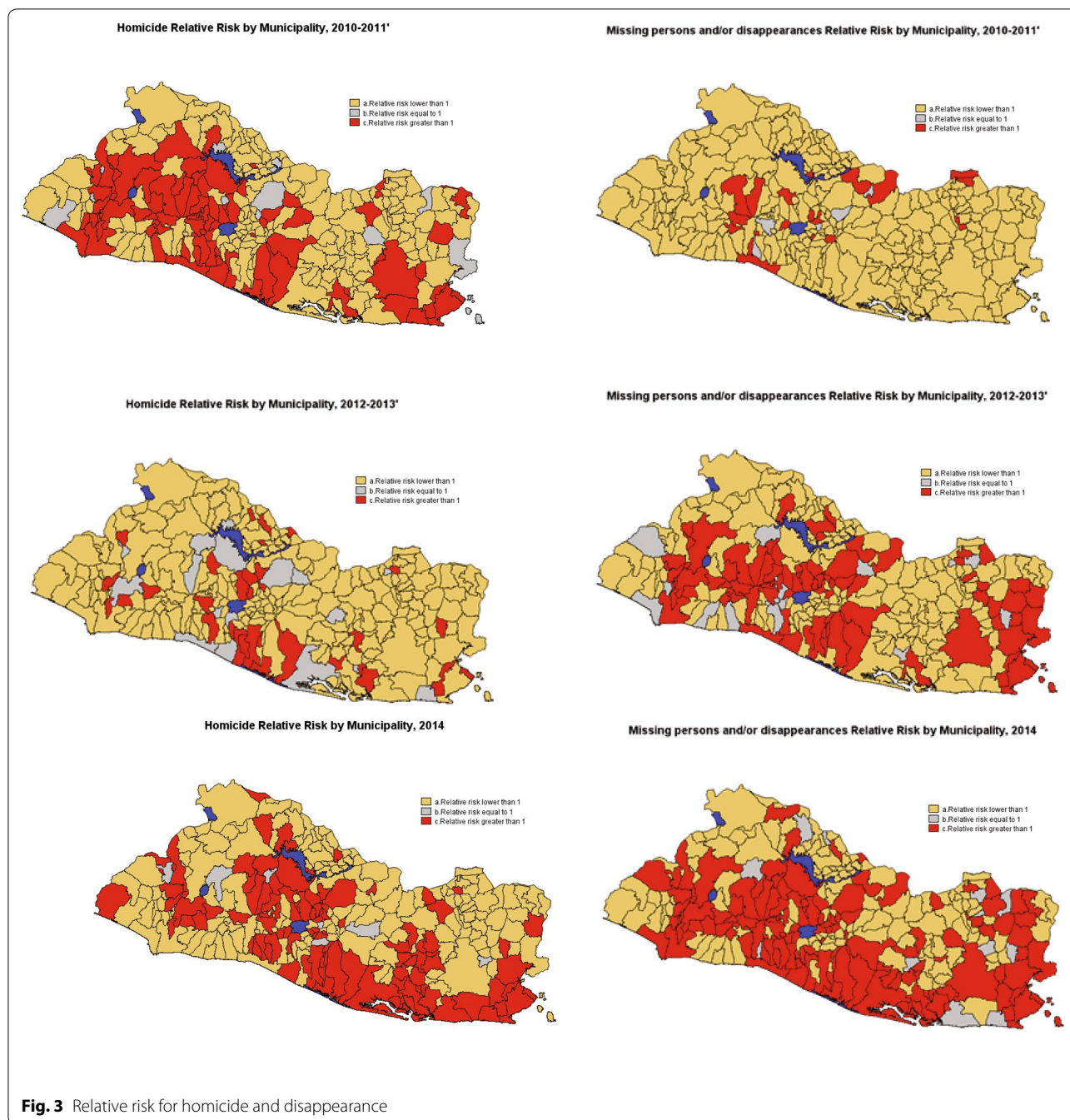
There were 81 municipalities with homicide risks exceeding one in 2010–2011 (first row and first column). Under the truce (i.e. 2012–2013), in 57 out of these municipalities, the risk dropped down to values that were smaller than one (second row and first column). On the other hand, in 2010–2011 there were 237 municipalities where the risk of disappearance took on values below one (first row and second column), 66 of which increased the risk to values greater than one during 2012–2013 (second row and second column). The maps in the third row of Fig. 3 show that following the end of the truce (2014), relative risks for both homicide and disappearance did not only increase but also seemed to have modified their geographical patterns.

### Disappearances and *maras*

Disappearances are not a new phenomenon to Salvadorian society. At least 8000 persons disappeared during the civil war of 1980s (Commission on the Truth for El Salvador 1993). During the last 10 years or so, forceful disappearances have occurred within a context of intense gang activity, mainly by the *Mara Salvatrucha* and *Barrio 18* gangs. The nature of gang-related disappearances is not clear cut. While it is true that the disappearance of a person implies her kidnapping, the most likely set up of most of the Salvadorian disappearances involves the murder and further clandestine burial by a gang, within the limits of a gang-dominated territory. The apparent gain of political power by *maras* as evidenced by an enhanced capacity to negotiate with government, together with an undisputed control over significant parts of the country’s territory and penitentiary facilities, may lead one to think of Salvadorian gangs as organizations that have evolved into a mix of mafia-like organizations and some form of politically motivated groups with characteristics that may be similar to those observed in paramilitary groups of Colombia and Mexico (Farah and Phillips Lum 2013; Ellis 2015).

The data in Figs. 2 and 3 provide support to the claim in Rivera Virúes (2014) that Salvadorian gangs are extending the use of the killing and secret burial of their victims. Initially and as a response to a government approach to crime control characterized by increased presence of police and army in the streets, gangs reduced the numbers of homicides committed in public places and replaced them with the clandestine burial of their victims.

Also and similar to forceful displacement (Cantor 2014) gangs might use disappearances to gain social control through either the intimidation of the residents of dominated territories, or ensuring their cooperation in protecting themselves against rival gangs or police. Demanding concessions from government to imprisoned gang members may be another factor underlying



**Fig. 3** Relative risk for homicide and disappearance

disappearances (Rivera Virués 2014). In 2010–2012, the country suffered a wave of disappearances, mostly young people and teenagers, who went missing without explanation in a phenomenon linked to the gang violence hitting the country (Stone 2011, 2013; Sánchez-Aiscorbe 2014). In El Salvador, most accounts on this type of violence come from the media.

Outside the context of political violence and drug wars, in Latin America, the disappearance of persons

has been related to paramilitary groups as in the case of Colombia (Rozema 2008; Hristov 2010), and the so called self-defense forces, as in Mexico (Santamaría 2014). Literature on disappearances related to gang activity is almost inexistent. Rivera Virués (2014) is the only academic work on the topic that also refers to the specific case of El Salvador.

Based on field research, Cantor (2014) analyzed the broad dynamics of the closely related phenomenon

of forced displacement provoked by organized crime groups—*maras*, Central American drug transporters, and Mexican drug cartels. Structural differences between these groups influence both the forms of displacement that they produce and the resulting patterns of movement by displaced persons. The reasons underlying someone’s disappearance, killing and secret burial might be similar to those causing displacement. Disappearance can be dealt with as an intermediate outcome in the process of population displacement caused by gangs.

Cantor (2014, p. 11) proposed two distinctive forms of population displacement: those resulting from the “everyday activities” of criminal groups; and those resulting from the periodic violent disputes between them. Regarding the former and from the standpoint of the criminal group, displacement may occur due to betrayal or enmity; resistance; land appropriation; and insecurity. Grounds for displacement related to the latter have to do with disputes between gangs, between *Transportistas* and between Mexican cartels. We pay attention to possible links between “everyday activities” of gangs and disappearances.

In El Salvador and at the national level, the *Mara Salvatrucha* and the *Barrio 18* gangs are structured through prison-based “councils” of leaders that provide only broad direction to local groups of *mara* members known as *clicas*, each of which operates with a large degree of autonomy in its own territory. Gangs operate in urban and sub-urban areas and divide their territory into a *clica’s* core and “extended” zones of operation. Members of the *clica* live in the “core” zone that is located in one or more marginal urban neighborhood and from it carries localized criminal activities such as drug-dealing. These areas concentrate unusually large rates of violence. The “extended” areas are those where *clicas* enter more sporadically to extort businesses and sometimes residents, and where there is presence of public and private security. In “core” zones, the *clicas* ensure the support from local residents by imposing codes of conduct on them. Observance of these rules is backed up by violence and other control mechanisms (Cantor 2014, p. 7).

**On this research**

This paper uses data on official records of disappearances and homicides to explore joint spatial behavior across municipalities in El Salvador over the period 2010–2014. It aims at identifying spatial patterns to the practice of forced disappearances by *maras* by exploring their spatial correlation with homicides. We separate the underlying risk surface for each crime into a shared and a crime specific component. We predict the strongest effect of the unobserved shared component on the risk of disappearance.

**Methods**

A Bayesian model with shared components (Knorr-Held and Best 2001) was implemented to jointly account for the effect of unobserved common influences on the risk of both the disappearance of persons and homicide. This approach was deemed convenient as it was believed that most variation in relative risk was due to differences in gang activity across municipalities.

The data for this study consisted of the numbers of disappeared persons and homicides occurring at each of the 262 municipalities across the country over the 5 year period spanning from 2010 to 2014. Data on homicides were obtained from the *Instituto de Medicina Legal*, and data on disappeared persons came from the *Policía Nacional Civil*. Official population projections obtained from the *Dirección General de Estadística y Censos* were used in the computation of rates. We analyze the data over three periods: 2010–2011 (prior to the gang truce), 2012–2013 (under the truce), and 2014 (following the end of the truce).

Let the  $i$  index designate a municipality, ( $i = 1, 2, \dots, 262$ ), and the  $k$  index, a specific outcome,  $k = 1$  for *disappearance* and  $2$  for *homicide*. The number of incidents in municipality  $i$  for outcome  $k$ ,  $Y_{ik}$ , follows a Poisson distribution with mean  $E_{ik} \theta_{ik}$ . In this expression,  $\theta_{ik}$  is the unknown relative risk of person disappearance or homicide and  $E_{ik}$  is the expected number of disappeared persons or homicides in municipality  $i$ . Risks are estimated by (indirectly) standardized rates (SRs). In order to implement the Bayesian approach to the modeling of disappearance and homicide risk, a same Poisson distribution was assumed at the first level of hierarchy, given by

$$Y_{ik} | \theta_{ik} \sim \text{Poisson}(E_{ik} \theta_{ik}) \tag{1}$$

The use of SRs as estimates of relative risk assumes a constant rate over each local area and outcome. For rare events such as disappearances or homicides, the variation in the numbers of incidents exceeds that predicted by a Poisson process. Extra variation may arise either from common unobserved heterogeneity that may be dominated by gang activity, or from the spatial clustering of incidences, or both. Allowing area-specific risks to depend on a latent variable (a random effect), the variance of which reflects the degree of extra-Poisson variation, is a standard approach to accommodate overdispersion in counts in the epidemiological literature (Mollié 2000; Lawson 2013 and references therein).

At the second level of the hierarchy, the logarithms of the relative risks were defined as

$$\log(\theta_{i1}) = \alpha_1 + \delta W_i + U_{i1}, \text{ for disappearance,} \tag{2}$$

and

$$\log(\theta_{i2}) = \alpha_2 + \frac{W_i}{\delta}, \text{ for homicide.} \tag{3}$$

In these expressions,  $U_{1i}$  is a separate random component for disappearance,  $W_i$  represents the shared component, and  $\alpha_1$  and  $\alpha_2$  are specific intercepts for disappearance and homicide, respectively. Finally,  $\delta$  is a scaling component for the contribution of the shared component to the overall relative risk that allows for differential risk gradients (on the log-scale) for each crime.

Prior distributions needed to be assigned to the parameters. The  $\alpha$  parameters were assigned improper uniform priors on the whole real line. The choice of these priors expressed the absence of genuine prior expectations on the parameter values. A normal prior with zero mean and variance  $\sigma^2_\delta$  was given to the logarithm of the scaling parameter ( $\delta$ ).

Conditionally autoregressive (CAR) priors (Besag et al. 1991) were used for the spatially structured random effects ( $U_{1i}$ ) and the common component random effect ( $W_i$ ). Under the CAR specification and for a given municipality, the mean of  $U_{1i}$  and  $W_i$  depends upon the  $U_{1i}$ 's and  $W_i$ 's of its neighboring municipalities. More formally,

$$U_{1i}|U_{1j}, j \neq i, \tau_u \sim \text{Normal}\left(\bar{U}_{1i}, \sigma_{u1}^2\right), \tag{4}$$

and

$$W_i|W_j, j \neq i, \tau_w \sim \text{Normal}\left(\bar{W}_i, \sigma_{w1}^2\right), \tag{5}$$

where,  $\bar{U}_{1i} = \frac{1}{m_i} \sum_{j \neq i} \omega_{ij} U_{1j}$ ,  $\bar{W}_i = \frac{1}{m_i} \sum_{j \neq i} \omega_{ij} W_j$ ,  $\sigma_{u1}^2 = \frac{\sigma_u^2}{m_i}$ ,

and  $\sigma_{w1}^2 = \frac{\sigma_w^2}{m_i}$ , with  $\omega_{ij} = 1$  if the  $i$ -th and  $j$ -th municipalities were neighbors and  $m_i$  was the number of municipalities that were neighbors to the  $i$ -th municipality.

Variance parameters  $\sigma_u^2$  and  $\sigma_w^2$  control the variability of the random effects  $U_i$  and  $W_i$  conditional upon the random effects in the neighboring municipalities, respectively. At the next level of hierarchy, uniform hyper-priors (i.e.  $U(0, 10)$ ) were assigned to the variance parameters ( $\sigma_w^2, \sigma_u^2$ ).

We fitted the model in (1) and (2) to data on disappearances and homicide for three separate time periods. The first of these periods, 2010–2011, preceded the gang truce; the second, 2012–2013, corresponded to the time when the truce was in place; and 2014, when the truce was over.

The model was fitted using WinBUGS (Lunn et al. 2000), a programming language based software implementing MCMC algorithms to generate random samples from posterior distributions. The WinBUGS code for the model in (1) and (2) is available on request from the first author. Two chains were run and convergence was achieved by 20,000 iterations. A further 20,000 samples were run for each chain to obtain the desired posteriors

with Monte Carlo errors lower than 5% of the posterior standard deviation.

The general structure of the shared component model in (1) and (2) is discussed in Lawson (2013, p. 209). Earnest et al. (2010), MacNab (2010) and Chamanpara et al. (2015) are examples of recent applications in epidemiology. To the best of our knowledge and at the time of writing, the literature does not report on uses of this type of models in criminology.

From a criminological perspective, the shared common spatial component helps in understanding likely shifts in gang related violence to an increased use of the disappearance and further murder of individuals to either respond to police operations, or to adapt to new developments in drug markets or organized crime activities, or securing the control of territories, or all of the above.

### Results and discussion

The deviance information criterion (DIC) (Spiegelhalter et al. 2002) was used to assess the fit and identification of the model in (1–2) relative to a simpler model without a shared component. Models with smaller DIC are considered better. For each of the three periods, the shared component model had smaller DIC scores compared to separate models for disappearance and homicide (Table 1).

Table 2 details the model parameters from the shared component model. For disappearances, the ratio of relative risk associated with the shared component was found to be 1.85 (95% CI 1.04–4.00) in 2010–2011, 1.40 (95% CI 0.99–2.23) in 2012–2013, and 1.97 (95% CI 1.32–3.63) in 2014, indicating that unobserved gang activity common to both outcomes has a strong association with the disappearance of persons. The model also shows that 79, 46 and 66% of the between-municipality variation in relative risk of disappearance is explained by the shared component during 2010–2011, 2012–2013 and 2014, respectively. These figures indicate the presence of a strong spatial pattern in both homicide and disappearance.

The delta coefficient measuring the spatial correlation of homicide and disappearance took on values of 0.71 (95% CI 0.42–0.99) in 2010–2011, 0.84 (95% CI 0.67–1.00) in 2012–2013, and 0.73 (95% CI 0.59–0.87) in 2014, a result supporting the hypothesis that both homicide and disappearance are outcomes from unobserved processes associated with geographic variations of *mará* related activities (see last row of Table 2). As expected, the correlation of homicide and disappearances was strongest in 2012 the year the gang truce was in place (0.84) but this coefficient was large before the truce (0.71 in 2010–2011) and remained as such after the truce was over (0.73 in 2014).

**Table 1 Summary of deviance information criteria for competing models**

	2010–2011		2012–2013		2014	
	pD	DIC	pD	DIC	pD	DIC
<i>Shared component model</i>						
Disappearances	118.51	811.00	142.44	1190.72	141.19	1091.74
Homicide	187.69	1495.18	145.82	1391.65	162.92	1313.77
Total	306.19	2306.18	288.26	2582.38	304.11	2405.51
<i>Individual models</i>						
Disappearances	120.85	815.95	144.41	1203.09	144.39	1104.28
Homicide	189.46	1496.30	151.28	1398.65	166.30	1318.35

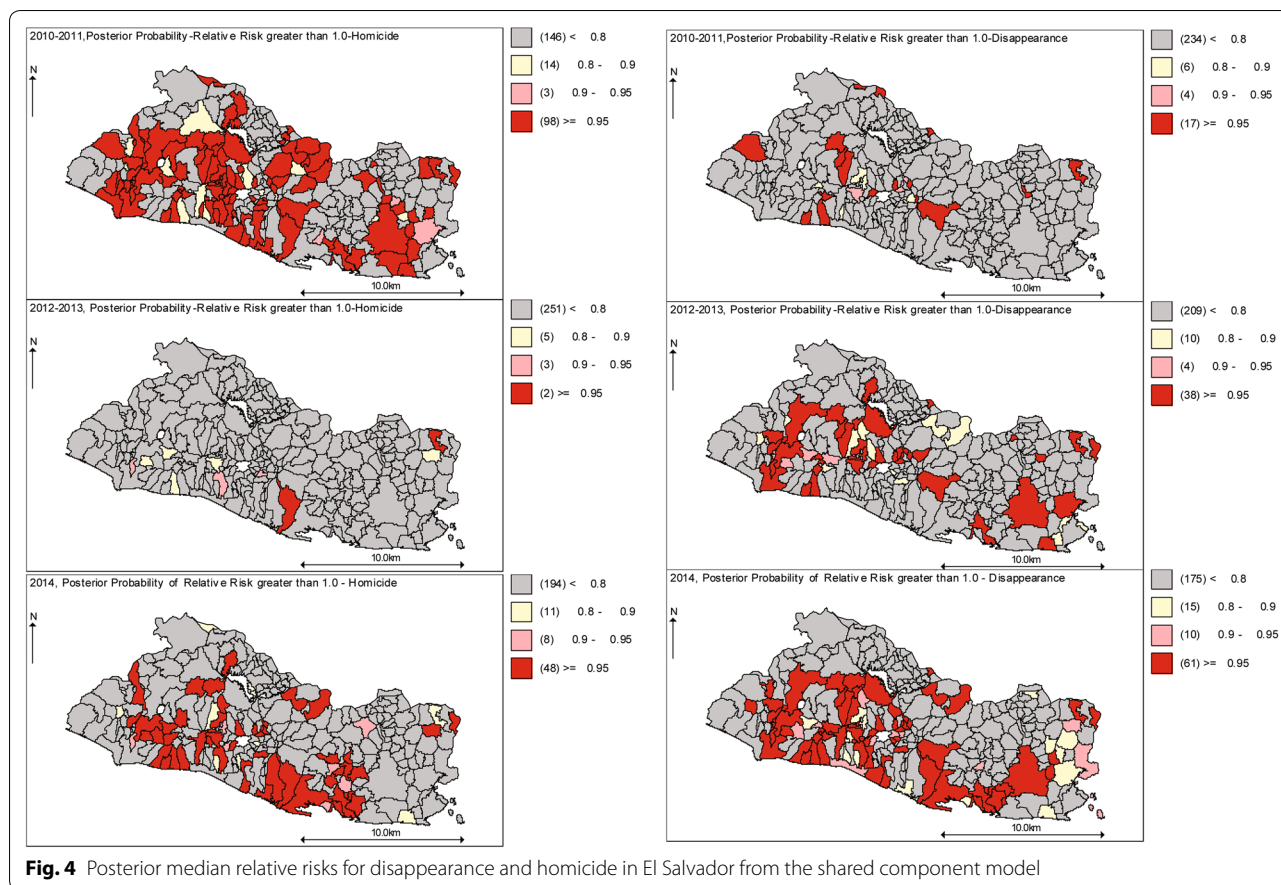
**Table 2 Summary of model parameters**

	2010–2011			2012–2013			2014		
	Estimate	Lower bound 95% CI	Upper bound 95% CI	Estimate	Lower bound 95% CI	Upper bound 95% CI	Estimate	Lower bound 95% CI	Upper bound 95% CI
Average logarithm of municipal-level risk of disappearance—exp ( $\alpha_1$ )	0.144	0.115	0.174	0.684	0.619	0.748	0.887	0.787	0.990
Average logarithm of municipal-level risk of homicide—exp ( $\alpha_2$ )	0.677	0.631	0.719	0.538	0.507	0.571	0.795	0.741	0.852
Ratio—Relative Risk associated with shared component	1.85	1.04	4.00	1.40	0.99	2.23	1.97	1.32	3.64
Fraction of variation in RR of disappearance explained by shared component	0.79	0.66	0.83	0.46	0.42	0.48	0.66	0.63	0.67
Delta coefficient $\delta$	0.71	0.42	0.99	0.84	0.67	1.00	0.73	0.59	0.87

For disappearance, municipal-level relative risks have varied around average values of 0.144, 0.684 and 0.887 during 2010–2011, 2012–2013 and 2014, respectively. In the case of homicide, municipal-level relative risks have varied around average values of 0.677, 0.538 and 0.795 over the same periods. These estimates suggest a convergence in national average relative risks of disappearance and homicide over time.

Figure 4 displays the overall posterior mean relative risk from the shared component model for both

homicide and disappearance. The data suggest that prior to the gang truce (i.e. 2010–2011), the relative risk for disappearance was larger in municipalities that also had large relative risks for homicide, most of them located in the central part of the country. During the truce (i.e. 2012–2013), the relative risk for homicide concentrated in a few municipalities located along the Pacific coast and one municipality located in the North–Eastern region. On the other hand and always during the time the gang truce was in place, the relative risk for disappearance



**Fig. 4** Posterior median relative risks for disappearance and homicide in El Salvador from the shared component model

not only continued being large for many of the municipalities where it also was large in the previous period (i.e. 2010–2011), but spread over municipalities located in the Eastern side of El Salvador. Finally, the maps in the last row of Fig. 4 indicate that after the truce was over, homicide risk recovered the spatial distribution it had during 2010–2011 whereas the risk of disappearance continued spreading over the territory.

These results suggest that in gang-dominated areas, the risk for disappearance has been large even before the truce was in place and that actually, it continues as such and going through a process of geographic expansion. These findings are consistent with an explanation of the phenomenon as a component of a strategy aimed at gaining sustained social control among residents of already gang controlled areas. According to the Salvadorian police, nearly 90% of disappeared persons are murdered by gangs. Clandestine graves are the final destination of most persons going disappeared. During 2007–2013, the *Fiscalía General de la República* conducted 145 inhumations in 30 clandestine cemeteries. Around 2007–2009, cemeteries were located in semi-rural deprived and gang-controlled communities of municipalities of the San Salvador metropolitan area. During 2009–2010, clandestine

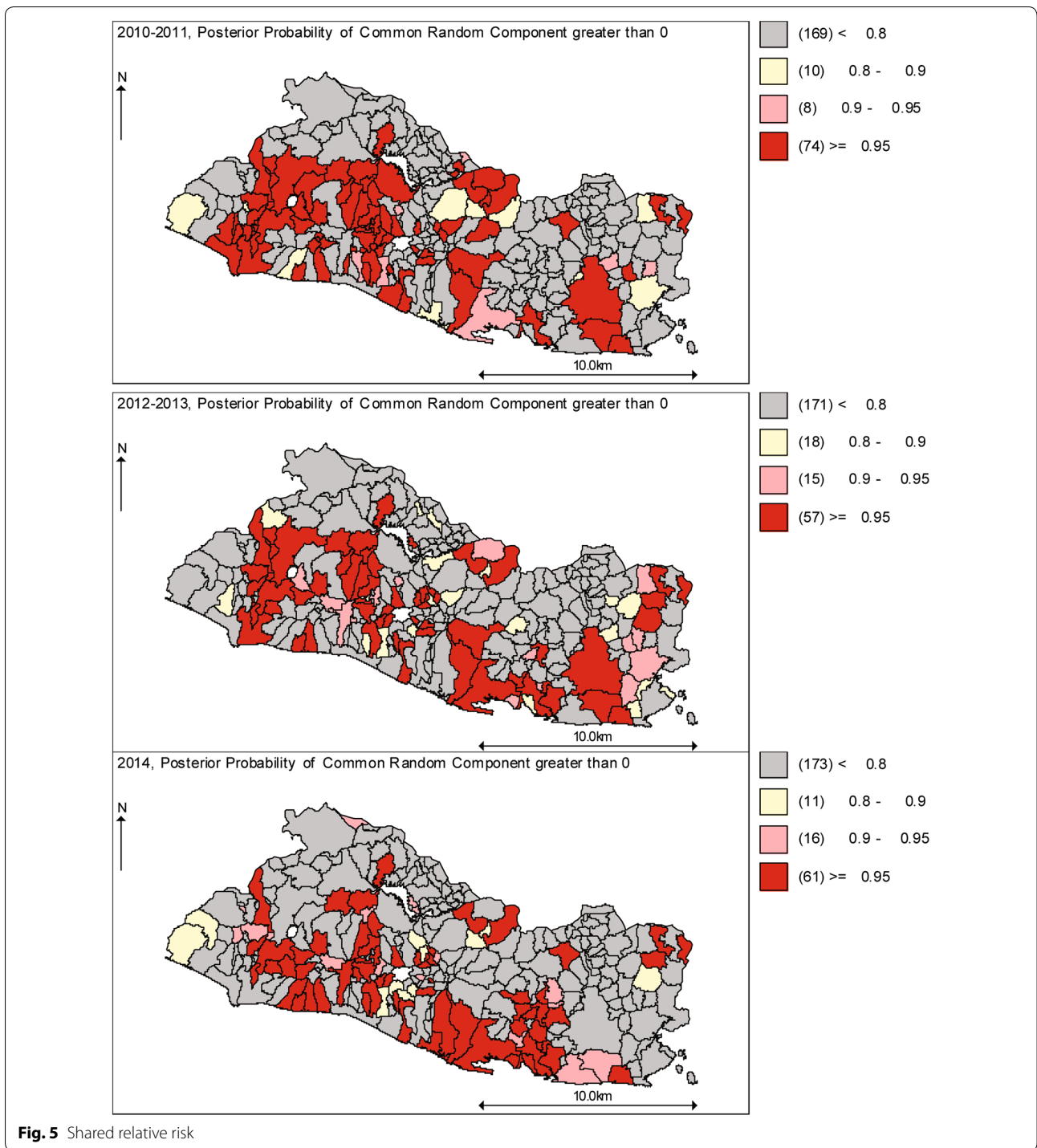
graves were discovered in the rural areas of the municipalities of Santa Ana and Usulután, located in the Western and Eastern sides of the country, respectively. Between 2011 and 2013, clandestine cemeteries were found in most of the territory indicating an expansion of the phenomenon (Rivera Virúes 2014, p. 61–62; Farah, 2016).

Figure 5 displays relative risk associated with the shared component. The maps might be taken as estimates of the evolution of the spatial distribution of gangs in El Salvador during 2010–2014. The data provide support to an explanation of violence as part of a process of territorial expansion and strengthening by *maras* to enhance their capabilities to interfere in the likely alliances of Mexican drug trafficking organizations with Central American criminal organizations specializing in the trans-shipment of drugs and in providing access to local markets to distribute and sell drugs (Dudley 2011; Santamaría 2014; Farah 2016).

**Conclusion**

This research implemented a Bayesian shared component model across municipalities of El Salvador to identify spatial patterns to the practice of forced disappearances by *maras* by exploring their spatial correlation





with homicides. We separated the underlying risk surface for each crime into a shared component, namely *maras* activity, and a crime specific component. We used data for three periods—before the truce (2010–2011), under the truce (2012–2013), and after the truce (2014)—to examine the hypothesis that most spatial variation in the relative risk of both homicide and disappearance

is due to differences in unobserved gang activity across municipalities.

In 2012–2013, the El Salvador’s government allegedly brokered a truce between the *Mara Salvatrucha* and the *Barrio 18* gang. Police data reveal that during the truce, homicides dropped by half. It has been argued that this decrease was not real due to large amounts of

disappeared persons. Police statistics indicate that the numbers of disappearances almost doubled during 2012–2013. It has been argued that the *maras* hid the large numbers of people still being killed by burying them in clandestine cemeteries.

The correlation of homicide and disappearances was strongest in 2012 the year the gang truce was in place but it was already large before the truce and remained as such after the truce was over. This finding suggests that—contrary to widely cited claims—Salvadorian *maras* did not initiate disappearances during the truce as a means of keeping the homicide rates low but there is a wider pattern to the practice of forced disappearances by these groups. This seems to be part of a strategy by *maras* to induce loyalty among members and other residents of their territorial strongholds, ensure compliance with systematic extortion demands and with *mara* codes seeking to eradicate alternative power structures as well.

Our findings show that as expected, there is a strong spatial pattern in both homicide and disappearance, and that most of this variation is associated with variations of *mara* related activities. These activities concentrate in geographical corridors connecting municipalities located along key drug-trafficking routes.

In El Salvador and since the truce, the risk for disappearance has continued extending over greater areas of the territory, a fact that suggests a wider pattern to the practice of forced disappearances by *maras*. Both forced disappearance and homicide are key parts of a process of territorial expansion by which *maras* enhance their capabilities to interfere in the alliances of Mexican drug trafficking organizations with Central American criminal organizations. These groups specialize in the trans-shipment of drugs and in providing access to local markets to distribute and sell drugs.

The main policy implication deriving from this research has to do with the need for the Salvadorian government to regain the territorial and social control of expanding portions of the country. Either the *Mara Salvatrucha* or the *Barrio 18* or both gangs seem to be involved in a conflict around the control of drug transport and distribution routes that are managed by other criminal organizations, allegedly linked to the Mexican drug trafficking groups and that most probably hold strong connections with locals.

#### Authors' contributions

CC designed the study, wrote the WinBugs code, conducted the statistical analyses, interpreted the results and drafted the manuscript. EA wrote, revised and implemented the WinBugs code, and helped interpreting the results and drafting the manuscript. Both authors read and approved the final manuscript.

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#### Competing interests

Both authors declare that they have no competing interests.

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