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Population density and governance in Africa

by Pranish Desai | October 2022

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Abstract

A long-standing, primarily qualitative body of scholarship has debated whether Africa's historically lower population densities are one of the factors responsible for some of the governance and developmental problems experienced by societies across the continent. This paper draws on this debate but applies a quantitative and geospatial approach by leveraging Afrobarometer Round 7 survey data and localised population density data to determine whether population density patterns are related to current governance outcomes at the sub-national level in sub-Saharan Africa. The primary sample is cross-sectional and reveals that meaningful statistical relationships do exist between variations in population density and experiences and perceptions of governance related to infrastructure quality, institutional trust, the rule of law, and citizens' satisfaction with government. Higher population densities at the sub-national level are associated with improved infrastructure but are also linked with lower trust in institutions, decreased satisfaction with government, and decreased confidence in the rule of law. These results are confirmed when we include several individual-level and group-level control variables, as well as when we use a second, independent data set. These findings have significant implications for policy makers across the fastest-growing and fastest-urbanising region in the world.

Acknowledgements

This article uses an updated data set but is methodologically based on research I undertook at the University of the Witwatersrand during the course of my master of arts in e-science degree, which was funded by a DSI-NICIS bursary. The views expressed in this research are my own and are not to be taken as representative of any associations and affiliations I have maintained. A link to my thesis on this topic is available at https://wiredspace.wits.ac.za/handle/10539/32124. The author would like to thank Rod Alence, Ross Harvey, Jeffrey Conroy-Krutz, and Brian Howard for their incisive comments on several iterations of this paper.

Introduction

Historically, sub-Saharan Africa has been characterised by low population densities, especially in inland areas (Badenhorst, 1951; Green, 2012a; Griffiths, 1995). Over the last 50 years, this has changed. The region now contains countries with some of the fastest population growth and fastest urbanisation rates on Earth (UN Habitat, 2016). Many scholars have sought to determine whether these low historic density patterns are one of the factors behind the region's struggles with governance and economic development. Among the specific issues scholars have linked to sub-Saharan Africa's traditionally low population densities are state size, governance capacity, economic development, inequality, and conflict (Green, 2012a; Herbst, 2014; Stephan & Tedrow, 1974).

However, until recently, most studies on this topic were primarily qualitative in nature. The principal reason for this was the absence of reliable population data, a consequence of many African societies lacking the resources and technical capacity necessary to conduct large-scale data collection projects such as national population censuses. The dearth of quantitatively focused studies evaluating the relationship between population density and governance in Africa represents a gap in our current understanding of this issue. Furthermore, the existing quantitative work largely considers the issue at the national level as opposed to the sub-national one, even though the latter is often the most relevant level to assess the quality of governance and development. This study partially addresses this void in our current understanding of the population density-governance relationship. The research question this study addresses is: Do variations in population density have a determinative effect on experiences and perceptions of governance at the sub-national level in sub-Saharan Africa?

The study uses a combination of quantitative and spatial methods to estimate whether experiences and perceptions of governance at the sub-national level differ between lower-density areas and higher-density areas. Methodologically, the study takes a unique approach by merging newly available geographically referenced data taken from the pan-African survey Afrobarometer with localised population-density data taken from the WorldPop Project. The final data set comprised 37,294 geographically referenced data points from 27 African countries recording 2018 data for population density and four measures of governance quality: infrastructure quality, institutional trust, the rule of law, and satisfaction with government. Whereas the first indicator of governance quality is an "objective" measure, in that it measures access to specific infrastructural facilities, the last three indicators are "subjective," measuring citizens' perceptions of government performance. This approach enables the study to analyse governance in a more holistic way, since it assesses both the realities of infrastructure at the local level and citizens' perceptions.

The body of research underpinning this study has close links with the literature on how the urban-rural divide in sub-Saharan Africa has influenced the political economy of the region. This literature provides some reasons as to why we might expect a direct relationship between population density and governance quality – that is, increases in population density are expected to correspond with better governance. One of the main arguments provided within this scholarship is the notion that throughout the region's history, rulers have struggled to solve the endemic challenges of inefficiency and inaccessibility caused by having to govern across sparsely populated lands from distant capitals (Herbst, 2014). Consequently, across pre-colonial, colonial, and post-colonial times, many African societies have been hindered by having a weak state apparatus unable to carry out essential functions, including border security, public goods distribution, and tax collection (Herbst, 2014; Robinson, 2002). The effect of this on the state of governance at the local level was that lower-density areas were often under-resourced and therefore struggled when grappling with problems of governance compared to higher-density areas. The problem was exacerbated by the "urban bias" of many colonial and nascent post-colonial governments, which were more likely to intervene in support of urban residents through policy actions such

as investment in infrastructure and price controls (Bates, 1987; Krönke, Mattes, & Naidoo, 2022).

The study finds that there are meaningful links between variations in population density and experiences and perceptions of governance at the sub-national level in sub-Saharan Africa. Presence in a high-density area is linked with superior infrastructure, but citizens in these areas are also less trusting of institutions, less satisfied with government performance, and less likely to believe that the rule of law exists within their society.

These findings are of particular importance given the seismic demographic changes the African continent has experienced over the past half-century. The results can assist policy making by identifying some of the demographic and geographic patterns associated with different intrastate levels of infrastructure quality, institutional trust, and satisfaction with government.

Background

This study's examination of the relationship between population density and governance outcomes draws on a substantive, albeit primarily qualitative, body of work. This section provides a critical overview of this literature, with emphasis on studies linking Africa's historically low population densities with issues of development and governance.

The capacity of societies in Africa to collect and produce reliable population measures has historically been limited by a lack of resources and technical capacity to conduct censuses (Badenhorst, 1951). These problems are prominent in early publications of population estimates for the continent. One such publication was the United Nations Demographic Yearbook of 1949 (United Nations, 1950), which estimated that Africa's total population at the time was 198 million people. However, the report posited that only 44% of this estimated continental population had experienced a census of a "fair" degree of reliability. This lack of reliability meant that the report classified its own overall estimates of African populations as "poor." Despite this questionable reliability, the report is also noteworthy for providing some of the earliest quantitative suggestions that much of Africa – particularly inland Africa – was characterised by low population densities. The report estimated that the continent had an average population density of 6.5 persons per km^2 in 1949. This figure was much lower than the estimated global average of 18 persons per km^2 and lower than any region of the world with the exception of Oceania (United Nations, 1950).

Following countries' independence, studies continued to be hindered by the inability of African states to conduct proper censuses, especially in rural areas (Badenhorst, 1951; McEvedy & Jones, 1978; Stephan & Tedrow, 1974). Notwithstanding this, there remained a consensus among governments, international organisations, and demographers that population densities were generally low across the continent. For instance, a 1976 study estimated that 67 out of 101 tribal territories had an average population density of fewer than 60 people per square mile. At the national level, 21 out of 33 countries recorded population densities below this benchmark (Vengroff, 1976).

With the gradual improvement in statistical capacities in Africa, the last half-century has seen a body of research connecting the historic sparseness of African societies with developmental and governance challenges. Several specific governance-related challenges have been linked to these unique population distribution patterns, including conflict, economic development, governance capacity, and inequality. As Alence (2017) observes, research on African governance has tended to be "broadly institutionalist in its attention to the organisation of political life." The implication is that this field of study has tended to focus on how governance institutions are affected by variables such as social actors, political actors, and cultural antecedents. Broader scholarship on the topic of governance, such as *The Narrow Corridor* by Acemoglu and Robinson (2019), also identifies population density as one of several factors – others include established trade links and the presence of industry – that have historically improved state capacity.

A prevalent line of argument regarding why lower population densities in Africa are associated with adverse governance outcomes posits that these population patterns have meant that resource-constrained societies in Africa have found it challenging to rule hinterlands, especially from distant capitals, due to the resource intensiveness of such endeavours (Herbst, 2014). Thus, the greater historical prevalence of remote areas in Africa has meant that these struggles were more common than in parts of the world with higher average densities. This literature also points to potential issues of reverse causality. For example, urban areas might generate incentives for building and maintaining infrastructure, but this improved infrastructure is itself one of the drivers of intrastate migration from lower- to higher-density areas (Bates, 1987). What this suggests is that while increases in population density improve the chances that an area gets superior infrastructure, better infrastructure can also increase population sizes and densities due to the attraction it holds for individuals. Of further importance is the fact that there is considerable evidence that much of this migration from rural to urban areas is driven by young adults in search of opportunity (Menashe-Oren & Stecklov, 2018). This is the demographic most likely to have children and in turn make demands of the state regarding the building of schools and other critical infrastructure.

Beyond the concern regarding how population density influences infrastructural outcomes, several studies on the density-governance relationship have explored how population density has influenced outcomes such as state formation, state consolidation, and resource provision (Bates, 1987; Stephan & Tedrow, 1974; Vengroff, 1976). Other studies on this topic have associated the lower historical densities with weaker capacities for public-goods provision across the pre-colonial, colonial, and post-colonial periods in African history (Gennaioli & Rainer, 2007; Green, 2012a; Herbst, 2014). There are some dissenting voices in this scholarship, with Osafo-Kwaako and Robinson (2013) finding a significant, positive correlation between population density and political centralisation across the world – yet the correlation has no significance in explaining political centralisation patterns in pre-colonial Africa.

The most important qualitative study on the link between population density and governance within sub-Saharan Africa is Jeffrey Herbst's *States and Power in Africa* (2014). Herbst posits that, historically, rulers struggled with sustaining the resources and effort required to maintain control over sparsely populated lands. As a consequence, large parts of the continent have faced perennial problems with fulfilling essential governance responsibilities, such as efficient public-goods distribution, ensuring border security (Englebert, Tarango, & Carter, 2002), and tax collection (Frankema, 2011; Kasara, 2007). Going by this argument, sub-Saharan Africa's challenges with state formation and state consolidation are rooted in historically scattered populations (Herbst, 2014).

Other scholarship has considered the influence these population density patterns have had in providing a trigger for conflict in Africa. Research has found that areas in Central Africa with several population clusters at the local level are more likely to experience conflict (Raleigh & Hegre, 2009). Similarly, the historically low densities of the continent have also been connected with ethnic fragmentation, increased poverty levels, and inadequate property rights (Green, 2012b). These issues have been aggravated by the increased prevalence of land disputes, which often become violent.

Scholarly interest in the density-development issue also takes a land-orientated approach, arguing that land-abundant, low-density societies struggle with development due to their smaller, sparser labour forces (Hopkins, 2009; Nunn & Puga, 2012; van de Walle, 2009). Most notably, Acemoglu, Johnson, & Robinson (2002) argue that pre-1500 Africa had higher urban densities when compared to other regions such as the modern-day Americas and Oceania, which suggests greater levels of prosperity in pre-colonial Africa. The "reversal of fortune" Africa experienced in terms of population densities and prosperity is primarily rooted in the legacies of colonization and the slave trade.

The slave trade was responsible for exacerbating the disjunction between the continent's ample landscape and the labour shortages it caused. Scholars estimate that the

transatlantic and Indian Ocean slave trades were so influential that the total population size of the continent likely remained stagnant for an entire century between 1790 and 1890 (Akyeampong, Bates, Nunn, & Robinson, 2014). Other studies have also found an inverse correlation between European presence in an area and the corresponding population density (Angeles & Neanidis, 2015). These authors argue that without the slave trade and European colonisation, the land-population disparity would have been less severe, as was the case in other colonised parts of the world, such as South Asia and Central America. Therefore, many societies across Africa would have been better placed to continue their pre-colonial economic development trajectories (Austin, 2008).

More recently, the emergence of satellite imaging has resulted in a resurgence of interest in studying the links between population density, inequality, and economic development in post-colonial Africa (Fosu, Bates, & Hoeffler, 2006; Min, Gaba, Sarr, & Agalassou, 2013; Mveyange, 2015). For instance, Fosu et al. (2006) argue that the example offered by states like Botswana provides a guide that individual states in sub-Saharan Africa can still attain improved levels of economic development despite their sparse landscapes. Studies have also found links between proxies of population density such as night-time lights and regional inequality (Mveyange, 2015) as well as poverty within countries at the provincial/state/regional level (Gosh, Anderson, Elvidge, & Sutton, 2013).

Despite this renewed interest in how population density patterns influence developmental outcomes in the contemporary African setting, there is a dearth of analysis examining how these patterns influence present-day experiences and perceptions of governance in the region. Applying statistical and geospatial methods, this study locates itself as part of this newer strand of scholarship, but with a more governance-oriented approach.

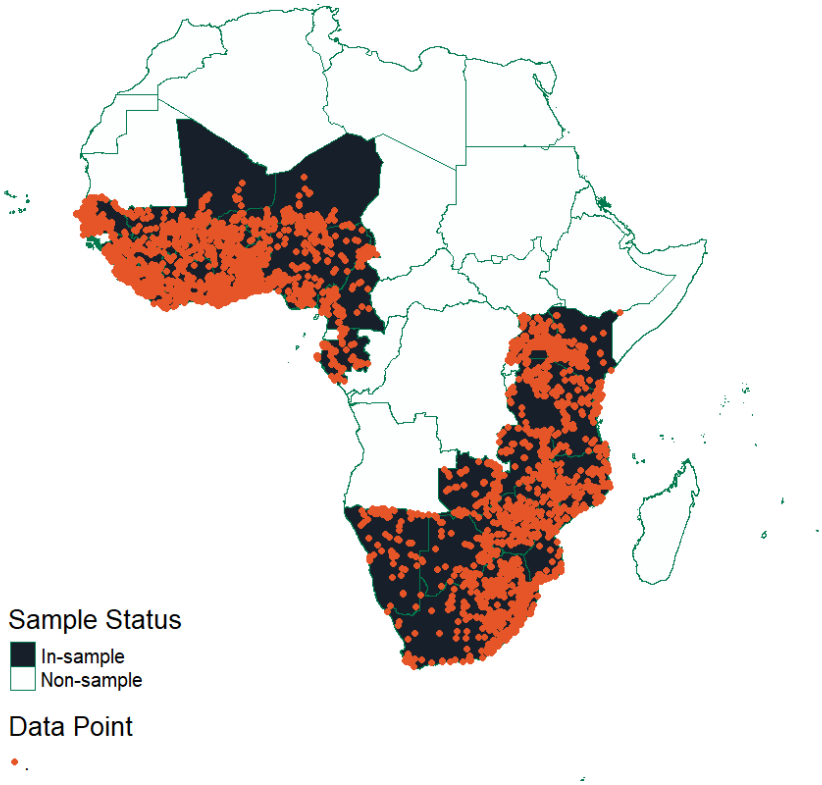
Data and methods

The development of technologies such as satellite imaging is one of the factors that have improved the quality of population data for the continent (Lloyd et al., 2019; Lloyd, Sorichetta, & Tatem, 2017). Such innovations have allowed for the mapping of conventional measures of population and population density through data sources such as the University of Southampton WorldPop Project (2022a) and NASA's Socioeconomic Data and Applications Center (2022). The development of this technology has coincided with the improved capacity of many African governments to collect demographic data through efforts such as full-scale censuses. While concerns remain over the ability to collect data in "fragile" states, the overall trend in Africa has been one of improvement, especially when compared to the state of population data collection 50 years ago (Kiregyera, 2015).

The present study bases its analysis on a sample of 37,294 data points taken from 27 countries in sub-Saharan Africa, mostly in East, Southern, and West Africa. Figure 1 displays the sample of countries included in the study, as well as the locations of data points within those countries. To qualify as a sample country for the study, a country needed to be a non-island sub-Saharan African country where an Afrobarometer Round 7 survey was conducted.[1] Beyond issues of data availability, the rationale for sample selection was based on existing research on this issue, which has traditionally excluded North African and island countries due to historical and cultural differences (Herbst, 2014). 2018 is the most recent year for which data for both population density and sub-national governance quality are publicly accessible.

[1] The following countries were included in this study: Benin, Botswana, Burkina Faso, Cameroon, Côte d'Ivoire, Eswatini, Gabon, the Gambia, Ghana, Guinea, Kenya, Lesotho, Liberia, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Senegal, Sierra Leone, South Africa, Tanzania, Togo, Uganda, Zambia, and Zimbabwe. Appendix A contains more information about the sample.

Figure 1: Map of sample



This study applies a combination of geospatial and statistical analysis to assess whether population density is related to governance outcomes at the sub-national level in these 27 countries. It uses population density data collected from the University of Southampton WorldPop Project (2022a), which maps population distributions and settlements based on satellite imagery that is cross-referenced with geographically referenced data on settlement locations, land cover, and areas where habitation is not possible due to hostile environments or large bodies of water. To create gridded population estimates, these satellite images are merged with population data from sources such as national censuses and the United Nations demographic databases (University of Southampton WorldPop Project, 2022b). For this study, the population data were aggregated in the form of rasters, reflecting population density data for the year 2018. The number of persons per km^2 was measured at a resolution of 30 arc, which is approximately equivalent to 1km at the equator. These data were paired with georeferenced Afrobarometer data (N=37,294).

Four sub-national measures of governance quality were used to test the population density-governance relationship. These indicators measured infrastructure quality (IQI), institutional trust (ITI), rule of law (RLI), and satisfaction with government (SGI). Each indicator was measured on a 0-10 scale, with higher scores reflecting superior governance outcomes. These indicators were created using data collected during Round 7 of Afrobarometer (2022). Afrobarometer data are collected using a sample design that is nationally representative, stratified, and clustered, with the number of respondents per country ranging from 1,200 to 2,400. Data were geocoded by linking survey respondents to the coordinates of a larger enumeration area/primary sampling unit (BenYishay et al., 2017). Table 1 summarises the dependent variables, data sources, and definitions relevant to the study.

The four governance indicators were calculated with reference to specific answers given to Afrobarometer Round 7 questions. The questions used to calculate each indicator were answered either by the interviewer/field supervisor (IQI) or by respondents (ITI, RLI and SGI).

For the IQI, affirmative responses to 10 questions related to the presence of specific infrastructural facilities, including electricity grids, piped water, schools, and clinics, were aggregated to produce a score out of 10. For the three "subjective" governance indicators, measures were calculated using responses to various questions, including the extent to which respondents trusted institutions such as the head of state and Parliament (ITI); the frequency with which they believed a violation of the rule of law occurred, such as the head of state ignoring courts or Parliament (RLI); and the degree to which the government was satisfactorily dealing with policy areas such as job creation, providing basic services (water, electricity), and reducing crime (SGI).[2]

Table 1: Summary of variables, data sources, and definitions

Variable name	Afrobarometer questions used	Definition
IQI	Afrobarometer R7 (EA_SVC_A-D; EA_FAC_A-D; EA_FAC_F; EA_ROAD_A)	The extent to which a person has access to a set of infrastructural facilities
ITI	Afrobarometer R7 (Q43A-43K)	The extent to which a person trusts various governmental, political, and social institutions within their country
RLI	Afrobarometer R7 (Q39B-39C; Q42D-42F)	The extent to which a person believes that the rule of law exists within their society
SGI	Afrobarometer R7 (Q56A-56O)	The extent to which a person is satisfied with their government's handling of various policy action areas

There is some compositional overlap between the four indexes included in this study and previous indexed measures of citizen sentiment that have also used Afrobarometer data. Examples include the ITI and the trust in government/trust in state measures present in Krönke et al. (2022) and Mattes and Moreno (2018), the SGI and satisfaction with education services/health services included in Bratton (2009, 2012), and the SGI and satisfaction in micro-economic performance, macro-economic performance, and security performance measures created by Krönke et al. (2022). The main difference between the measures used in this study and these previous measures is that this study looks at more generalised aspects of citizens' sentiment toward governance, as opposed to the differentiated approach used previously.

In line with the existing literature, the expectation is that higher population densities are linked with superior infrastructure due to the better incentives for building and maintaining in these areas (Bates, 1987). One might also expect that higher densities are associated with greater confidence in institutions, the presence of the rule of law, and the government's dealing with various policy issues. One reason to expect this outcome would be the lingering opinions that citizens might have about the "urban bias" shown by many colonial and post-colonial African governments in terms of their historic tendency to intervene more regularly on behalf of urban interests compared to rural concerns (Bates, 1987). However, it should be noted that this "urban bias" has seen some reversals in recent years as a consequence of incumbent governments in Africa reacting to the significant support they tend to receive from voters living in rural areas by implementing policies that benefit these constituents (Harding, 2020).

These trends have at times been reflected in slight negative correlations between residing in an urban area and measures of trust in the government and trust in the state (Mattes & Moreno, 2018). Due to these differing impulses, there is less certainty around the expected direction of the relationship between population density and sentiment-based indexes. That said, one expectation we could reasonably have about these relationships is that they might

[2] For more information on the specific questions on which these four indicators are based, refer to Appendix B.

be less statistically apparent in terms of coefficient sizes when compared to the density-IQI relationship because of this potential of different forces working against one another.[3]

Multivariate linear models are used to test the extent of variation within each dependent variable attributable to the predictor variable while controlling for other individual-level factors that were measured at the level of the 37,294 data points themselves. The analyses also utilise mixed-effects models, which account for national-level control variables such as income levels and ethnic fractionalisation. Table 2 includes relevant summary statistics for variables included in the analyses. As the table shows, the median person within the sample is in their early 30s, has received some secondary education,[4] holds no part-time or full-time employment, and lives in a rural area. The distribution by gender is close to equal.

Table 2: Summary statistics for important variables (2018)

Statistic	N	Mean	St. dev.	Min	Median	Max
Population density (km^2)	37,294	2,759.93	5,640.70	1.00	405.40	88,228.41
Population density (log)	37,294	6.20	2.04	0.00	6.00	11.39
Employment	37,117	0.34	0.47	0.00	0.00	1.00
Urban	37,254	0.43	0.50	0.00	0.00	1.00
Age	37,266	36.68	14.80	18.00	33.00	106.00
Education	37,038	3.34	2.23	0.00	4.00	9.00
Lived Poverty Index	37,279	1.28	0.90	0.00	1.20	4.00
Infrastructure quality index	37,294	4.63	2.59	0	4	10
Institutional trust index	37,036	5.65	2.61	0.00	5.76	10.00
Rule of law index	36,822	5.83	2.40	0.00	6.00	10.00
Satisfaction with government index	36,900	4.15	2.16	0.00	4.22	10.00

The distributions of the four dependent variables of infrastructure quality (IQI), institutional trust (ITI), the rule of law (RLI), and satisfaction with government (SGI) demonstrate poor to middling governance outcomes at the sub-national level across the sample. Considering that each of these indicators is measured on a 0-10 continuous scale, it is revealing that the mean score for citizen satisfaction with government performance is only 4.15. A median score of 4 on the IQI demonstrates that more than half of the respondents do not have access to many critical infrastructural facilities, such as electricity grids, piped water, sewage systems, and health clinics. Scores on the ITI and RLI tend to be higher, which signals that, while satisfaction with government is low and access to infrastructure unequal, most respondents trust the political and social institutions of their country and believe that the rule of law exists in their society.

[3] Reporting whether a place is urban or rural is not the same as reporting whether an area is higher-density or lower-density, not least because there is substantially more numerical variation in different population densities compared to the urban/rural distinction, which in many cases only differentiates between those two categories. As such, it would be erroneous to base specific hypotheses on a conflation of the two. More general assumptions are possible as in most circumstances there are strong correlations between living in an urban area and higher population densities, and rural areas are closely linked to lower population densities (see Appendix A).

[4] Afrobarometer measures educational attainment on a categorical scale ranging from 0 (no formal schooling) to 9 (post-graduate education)

With regard to population density, there is a large gap between the mean of 2,759.93 persons per km^2 and the median of 405.40 persons per km^2, which suggests that the distribution of this variable has a substantial right-skew. Along with the exceptionally large standard deviation, this indicates that the variable is a candidate for logarithmic transformation, a method that prevents extreme values from being overly influential within the statistical models. For example, there are 28 occasions where the population density exceeds 50,000 persons per km^2 (Figure 2 and Table 3). The logic behind a logarithmic transformation is that ratio differences between values are more important than absolute differences. For instance, if one takes a set of data points with population densities of 50 people per km^2 and 100 people per km^2, and a second set of 1,000 people per km^2 and 1,050 people per km^2, then in both sets the absolute difference is 50 people per km^2. However, in percentage terms, the first represents a percentage increase of 100%, while for the second it is only 5%.

Figure 2: Population densities at 37,294 data points

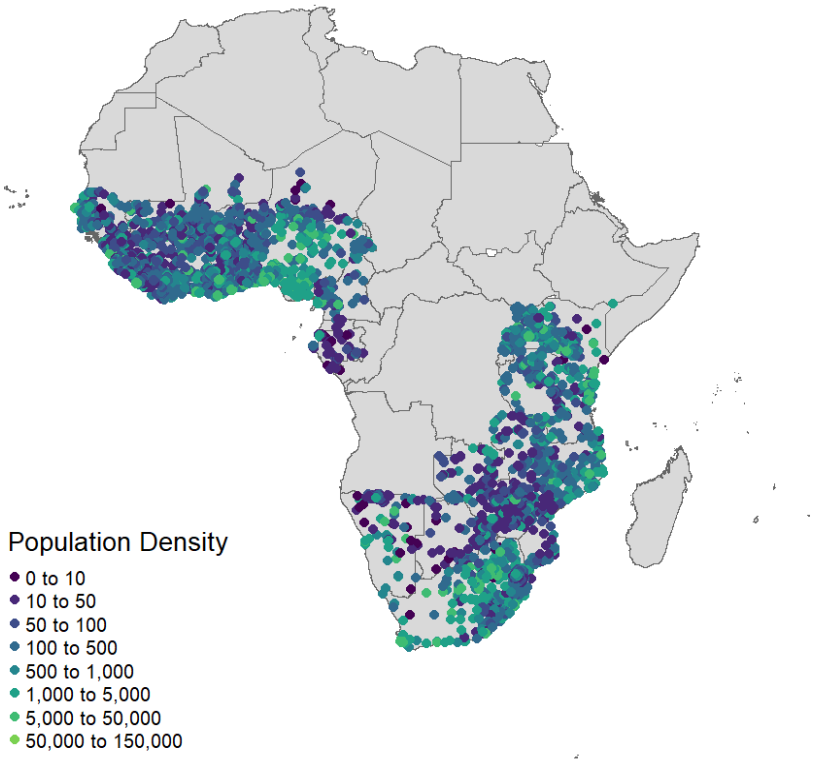


Table 3: Number of data points per 2018 population density category for 37,294 data points

Population density category (persons per km^2)	Number of points per category
0-10	740
10-50	4,102
50-100	4,204
100-500	10,713
500-1,000	3,623
1,000-5,000	7,711
5,000-50,000	6,173
50,000-150,000	28

Results

Table 4 displays the results for the bivariate relationships between population density and each of the governance outcomes. Directionally, there is a positive coefficient between population density and the IQI, and between population density and the SGI. This indicates that as population densities increase, we see a corresponding rise in the scores on the infrastructure and satisfaction indicators. By contrast, the negative coefficients for the ITI and RLI suggest that increases in population density are associated with worse performance on these "subjective" measures of trust and rule of law.

The bivariate relationships are strongest for the density-IQI (0.681) and density-ITI (-0.203) relationships. A one-unit increase in the log of population density corresponds to a 0.681 unit increase in infrastructure score.

In terms of statistical significance, the density-IQI, density-ITI, and density-RLI relationships are all significant at the 99% level, while the density-SGI relationship is not statistically significant at conventional levels. One reason for this is that the coefficient for this relationship is weak, at 0.009. With a range of between 0.00004 and 0.29, the R^2 and adjusted R^2 across these four models are generally low. This implies that much of the variation in the governance outcomes is explained by factors beyond the independent variable of population density.

The next few models address this issue by including control variables to see how the density-governance relationship changes when we consider other crucial factors.

Table 4: Summary of bivariate linear regression models (2018)

	Dependent variable			
	IQI	ITI	RLI	SGI
	(1)	(2)	(3)	(4)
Log(population density)	0.681*** (0.006)	−0.203*** (0.007)	−0.072*** (0.006)	0.009 (0.005)
Constant	0.406*** (0.036)	6.907*** (0.043)	6.276*** (0.040)	4.093*** (0.036)
Observations	37,294	37,036	36,822	36,900
R^2	0.290	0.025	0.004	0.0001
Adjusted R^2	0.290	0.025	0.004	0.00004
Residual std. error	2.180	2.574	2.392	2.156
F statistic	15,221.760***	958.525***	137.509***	2.420

*Note: *p<0.1; **p<0.05; ***p<0.01*

Table 5 shows the regression findings regarding the relationship between population density and the various indexes when we include individual-level controls for age[5], employment status, education, and gender.[6] These variables were selected on the basis of numerous studies linking such demographic factors with public sentiments (Drakos, Kallandranis, & Karidis, 2016). The other individual-level control variable included is Afrobarometer's Lived

[5] Due to its uneven distribution, the variable representing age underwent a transformation with values subjected to the power of -0.33.

[6] Whether a person lived in an urban or rural area was not included as a control variable due to concerns about multicollinearity given the high correlation between population density and urban/rural location (see Appendix A).

Poverty Index (LPI), a measure of the frequency with which respondents or their families went without basic necessities – including food, water, cooking fuel, medical care, and a cash income – during the previous year. Higher scores on the LPI suggest greater frequency in going without these necessities. Residents living in rural areas are more likely to experience deprivation compared to their urban counterparts (Mattes, 2020).

Table 5: Summary of multivariate linear regression models (2018)

	Dependent variable			
	IQI	ITI	RLI	SGI
	(1)	(2)	(3)	(4)
Log(population density)	0.595*** (0.006)	−0.154*** (0.007)	−0.083*** (0.006)	−0.020*** (0.006)
Education	0.236*** (0.005)	−0.254*** (0.007)	−0.077*** (0.006)	−0.086*** (0.005)
Employment	0.083*** (0.024)	0.079*** (0.029)	0.183*** (0.027)	0.099*** (0.024)
Male	−0.162*** (0.022)	0.110*** (0.027)	−0.052** (0.025)	0.034 (0.022)
Age	0.836*** (0.095)	0.650*** (0.114)	0.299*** (0.108)	−0.002 (0.094)
LPI	−0.184*** (0.013)	−0.417*** (0.015)	−0.411*** (0.014)	−0.669*** (0.013)
Constant	−1.297*** (0.205)	6.552*** (0.244)	6.476*** (0.231)	5.364*** (0.203)
Observations	36,902	36,676	36,458	36,557
R^2	0.338	0.079	0.030	0.076
Adjusted R^2	0.338	0.079	0.030	0.076
Residual std. error	2.105	2.501	2.356	2.071
F statistic	3,137.604***	527.710***	190.905***	500.976***

*Note: *p<0.1; **p<0.05; ***p<0.01*

Assessing these results, it is clear that the inclusion of control variables has had a varied effect on the strength of the relationships between population density and each of the four governance indicators. Whereas the coefficient for the density-IQI and density-ITI relationships decreased in strength but remained statistically significant, the coefficients for the density-RLI and density-SGI relationships increased. The most meaningful change is that the coefficient for the density-SGI relationship, which was positive and not statistically significant in the bivariate model, is now negative and statistically significant at the 99% level.

One important issue to note is that the overall predictive power of the models (R^2 scores) has risen following the inclusion of the control variables. The predictive power of the models for the three governance indicators (ITI, RLI, and SGI) measuring sentiments about governance quality remains noticeably lower than the one for the density-IQI relationship. This suggests that much of the variation in these governance outcomes can be accounted for by other factors excluded from the models. Among these potential factors are group-/national-level

factors such as income levels, national regime type, and levels of ethnic fractionalisation within a society. Furthermore, some of the variation would likely become clearer if the study used a panel data set and was therefore more longitudinal in scope. This would enable us to see how these relationships have changed over time.

It is also useful to observe the influence the control variables themselves have on governance outcomes. The results show that greater experiences of lived poverty are consistently linked with adverse experiences and perceptions of governance quality on each indicator. Employed individuals are more likely to have better access to infrastructure (0.083). They also display greater trust in institutions (0.079), higher levels of satisfaction with government performance (0.099), and greater confidence in the rule of law (0.183). As one would expect, better-educated respondents report better access to infrastructure (0.236). However, these respondents are also more skeptical of institutions (-0.254), the presence of the rule of law (- 0.077), and government performance (-0.086).

The next set of regressions includes national-level controls, incorporating gross domestic product (GDP) per capita (World Bank, 2022a), total land area (World Bank, 2022b), regime type (Center for Systemic Peace, 2022), and ethnic fractionalisation (Harvard Dataverse, 2019). These control variables were selected because of their prevalence as explanatory variables in studies examining the role of income levels, geography, ethnic politics, and types of institutions on governance (Alence, 2017). Table 6 reports on the results of these models.

Table 6: Summary of the mixed-effects regression models (2018)

	Dependent variable			
	IQI	ITI	RLI	SGI
	(1)	(2)	(3)	(4)
Log(population density)	0.645*** (0.006)	−0.153*** (0.007)	−0.067*** (0.006)	−0.004 (0.006)
Education	0.173*** (0.006)	−0.171*** (0.007)	−0.059*** (0.006)	−0.066*** (0.006)
Employment	0.138*** (0.024)	−0.086*** (0.029)	−0.032 (0.028)	−0.036 (0.024)
Male	−0.124*** (0.021)	0.085*** (0.025)	−0.032 (0.024)	0.047** (0.021)
Age	0.392*** (0.090)	0.885*** (0.110)	0.309*** (0.104)	−0.128 (0.090)
LPI	−0.206*** (0.013)	−0.279*** (0.015)	−0.266*** (0.015)	−0.501*** (0.013)
Constant	−0.558*** (0.206)	5.723*** (0.272)	6.325*** (0.230)	5.171*** (0.214)
Observations	36,902	36,676	36,458	36,557
Log likelihood	−77,263.450	−83,965.480	−81,467.070	−76,363.220
Akaike inf. crit.	154,566.900	167,971.000	162,974.100	152,766.400
Bayesian inf. crit.	154,737.200	168,141.200	163,144.200	152,936.600

*Note: *p<0.1; **p<0.05; ***p<0.01*

Compared to the bivariate and multivariate linear models, the introduction of group-level control variables does not have a large effect on the density-IQI, density-ITI, and density-RLI relationships. In all three cases, the directional effect, coefficient size, and associated level of

statistical significance have stayed close to the comparative values in the previous models. In terms of the national-level effects, countries in which data points reflect these patterns include Nigeria and South Africa, which have higher-density data points and higher levels of infrastructural quality compared to the norm across the 27-country sample. However, citizens in these countries also express greater skepticism about institutions and the existence of the rule of law (see Appendix A for more country-level information).

The effect of introducing country-level considerations is clearer in the case of the relationship between population density and satisfaction with the government. Whereas in the multivariate linear model the relationship had a coefficient of -0.02 that was significant at the 99% level, in the mixed-effects models the relationship is weaker, with the coefficient changing to -0.004. Furthermore, the relationship is no longer statistically significant at conventional levels. The implication of these divergent results is that among the four measures of governance quality, satisfaction with the government exhibits the weakest link with population density.

Robustness check

As a robustness check, the study also constructed identical sets of models with data from Round 6 of the Afrobarometer survey, which was conducted in 2014/2015 (Afrobarometer, 2017). The sample for this data set had 42,708 data points from 27 sub-Saharan countries.[7] Population density data were again obtained from the WorldPop database, but for the year 2015. Table 7 reports on the results produced from the mixed-effects models.

Table 7: Summary of the mixed-effects regression models (2015 sample)

	Dependent variable			
	IQI	**ITI**	**RLI**	**SGI**
	(1)	(2)	(3)	(4)
Log(population density)	0.378*** (0.005)	-0.127*** (0.006)	-0.071*** (0.005)	-0.040*** (0.005)
Education	0.225*** (0.006)	-0.148*** (0.006)	-0.069*** (0.006)	-0.035*** (0.006)
Employment	0.119*** (0.023)	-0.067*** (0.025)	-0.058** (0.023)	-0.141*** (0.023)
Male	-0.134*** (0.021)	0.040* (0.023)	-0.027 (0.021)	-0.006 (0.020)
Age	0.162* (0.095)	0.824*** (0.103)	0.219** (0.095)	-0.101 (0.092)
LPI	-0.262*** (0.012)	-0.322*** (0.013)	-0.304*** (0.012)	-0.519*** (0.012)
Constant	2.114*** (0.223)	5.532*** (0.238)	6.481*** (0.216)	5.259*** (0.209)
Observations	42,708	42,708	42,708	42,708
Log likelihood	-93,180.310	-96,327.050	-93,184.760	-91,576.830
Akaike inf. crit.	186,400.600	192,694.100	186,409.500	183,193.700
Bayesian inf. crit.	186,573.900	192,867.300	186,582.800	183,366.900

*Note: *p<0.1; **p<0.05; ***p<0.01*

[7] The list of countries in the 2015 and 2018 samples is identical except that Burundi was replaced by the Gambia in the 2018 data set.

Once again, population density is a statistically significant predictor of the IQI, the ITI, and the RLI. The signs on the coefficients for these three relationships also remain the same, although there has been a slight decrease in the strength of the coefficients when the IQI and ITI are the dependent variables.

The most noteworthy difference occurs when the SGI is the dependent variable: In the mixed-effects models with the 2018 sample, the coefficient of -0.004 was nonsignificant, while in the 2015 sample the coefficient of -0.04 is significant at the 99% level.

Discussion

Our results show that areas with higher population density were more likely to have better infrastructure. However, people living in these areas were also less likely to trust critical political, social, and governmental institutions; displayed lower levels of satisfaction with the government; and were less likely to believe that the rule of law exists in their society.

To a considerable extent, these findings provide support for the existing body of knowledge on the population density-governance relationship in Africa. Primarily qualitative research has connected the historically low population densities found in Africa with developmental and governance problems such as border insecurity, violent conflict, and low state capacity (Englebert et al., 2002; Herbst, 2014; Raleigh & Hegre, 2009). In particular, our finding that there is a positive relationship between population density and infrastructure quality provides a further basis for the claim that lower-density areas do suffer from some unique governance challenges in Africa.

While population density was found to be a meaningful correlate of "subjective" measures of governance quality, such as institutional trust and perceptions of the rule of law, the relationships were in the opposite direction to the one present in the density-infrastructure dynamic. That is, people living in lower-density areas were more likely to trust critical institutions and more willing to believe that the rule of law was enforced in their society. These findings may run counter to expectations one might have based on the historic existence of an "urban bias" in policy making in sub-Saharan Africa (Bates, 1987). This paper's findings lie closer to a more recent stream of research in social psychology that looks at the determinants of responses in social surveys.

A prevalent finding in these studies is that there is a population density-based divide in the perceptions held by individuals. Specifically, dwellers in higher-density areas are often more skeptical about the state of their society compared to their counterparts in lower-density areas, even though residents in higher-density areas often have higher living standards (Walton, Murray, & Thomas, 2008). Other studies have found negative correlations between higher population densities and sentiments around factors such as "quality of life" and "perceived quality of neighbourhood" (Fassio, Rollero, & de Piccoli, 2013; Greyling & Rossouw, 2017; Kanbur & Venables, 2005).

This paper raises two points to consider in trying to account for why individuals living in higher-density areas in Africa might be more skeptical about government performance despite better access to infrastructure and services. The first concerns the effect of educational attainment on the relationship between population density and sentiment on governance. According to our multivariate models, Afrobarometer respondents with higher levels of formal education have access to better infrastructure but also display lower levels of trust in institutions and are less confident about the presence of the rule of law and government performance (see tables 5 and 6). One reason for this effect could be the presence of an "expectations gap," i.e. individuals who have attained higher levels of education have greater expectations in terms of government performance and institutions compared to those with less formal education.

The second, a more political explanation, relates to the fact that in much of Africa, incumbent governments are more popular in rural (often lower-density) areas. By contrast, higher-density areas, especially those in urban locales, are often where opposition parties tend to perform best in electoral terms (Harding, 2020). There are several reasons for this, but

one of the more salient ones is that it is a consequence of the inability of opposition parties to extend their influence further away from capitals and major cities. This is particularly relevant when compared to the advantages available to incumbent governments. Moreover, residents in urban areas are more likely to say that they are dissatisfied with democracy compared to those in rural areas (Harding, 2020). These factors may help explain why residents of higher-density areas are more likely to express skepticism about governance institutions, government performance, and the idea that the rule of law is present in their society despite their generally superior standard of living.

While infrastructure quality on the continent is generally low (see Table 2), the stark disparity between higher- and lower-density areas in infrastructure quality is of clear concern for policy makers. Governments across the continent need to invest in critical infrastructure, especially schools, health facilities, electricity, piped water, and paved roads. This is an especially relevant concern given that there is evidence that "lived poverty" in a number of African countries has been rising since 2016 (Mattes, 2020) – a trend that has likely been exacerbated by the COVID-19 pandemic. Governments that fail to invest in critical infrastructure in both high-density and low-density areas risk worsening this backsliding in living standards, an outcome that would have a devastating impact on key indicators such as life expectancy, child mortality, and literacy rates. The experiences of countries such as Botswana suggest that lower-density societies can use proactive and effective policy making to mitigate demographic disadvantages and their links with less developed infrastructure (Fosu et al., 2006).

Africa is the fastest-growing and fastest-urbanising continent (UN Habitat, 2016). Based on the results reported in this study, residents of higher-density areas – which tend to be urban – are on balance more skeptical of government institutions and government actions. Growing urbanisation could therefore increase the likelihood of legitimacy crises across the continent, particularly if rural-to-urban migration continues to be driven by young adults who have higher levels of educational attainment (Menashe-Oren & Stecklov, 2018). Governments that fail to recognise and address their concerns risk being caught in a vicious cycle of governance failure and citizen dissatisfaction.

Future research can enhance our understanding of the relationships between population density and governance in at least two ways. The first is by using a panel data set – for instance merging multiple Afrobarometer rounds with several sets of population density data. This longitudinal focus would assist policy makers and researchers by providing more information about how this relationship has operated in Africa over time. The second is by assessing whether the findings of this study are unique to sub-Saharan Africa by linking population density data to public survey data taken from other regions.

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Appendixes

Appendix A: Sample information

The study comprised 37,294 data points taken from 27 countries in sub-Saharan Africa. Appendix A provides more information about this sample.

Table A.1: Country and country code list

Country	Afrobarometer code	ISO 3 code	Afrobarometer respondents (R7)
Benin	BEN	BEN	1,200
Botswana	BOT	BWA	1,198
Burkina Faso	BFO	BFA	1,200
Cameroon	CAM	CMR	1,202
Côte d'Ivoire	CDI	CIV	1,200
Eswatini	SWZ	SWZ	1,200
Gabon	GAB	GAB	1,199
Gambia	GAM	GMB	1,200
Ghana	GHA	GHA	2,400
Guinea	GUI	GIN	1,194
Kenya	KEN	KEN	1,599
Lesotho	LES	LSO	1,200
Liberia	LIB	LBR	1,200
Malawi	MLW	MWI	1,200
Mali	MLI	MLI	1,200
Mozambique	MOZ	MOZ	2,392
Namibia	NAM	NAM	1,200
Niger	NGR	NER	1,200
Nigeria	NIG	NGA	1,600
Senegal	SEN	SEN	1,200
Sierra Leone	SRL	SLE	1,200
South Africa	SAF	ZAF	1,840
Tanzania	TAN	TZA	2,400
Togo	TOG	TGO	1,200
Uganda	UGA	UGA	1,200
Zambia	ZAM	ZMB	1,200
Zimbabwe	ZIM	ZWE	1,200

Table A.2: Number of data points per 2018 population density category within raster data for 27 African country sample

Population density category (persons per km^2)	Number of points per category
0-10	8,085,776
10-50	3,796,657
50-100	1,271,541
100-500	1,258,241
500-1,000	131,394
1,000-5,000	79,170
5,000-50,000	13,012
50,000-160,000	56

Table A.3: Mean values for key variables by country (2018)

Country	Population density per km²	IQI	ITI	RLI	SGI
Benin	1,930.02	4.69	5.38	6.18	3.95
Botswana	414.31	6.48	6.29	6.88	5.45
Burkina Faso	1,400.74	3.65	6.83	5.88	4.46
Cameroon	3,302.63	5.94	5.08	5.33	3.72
Côte d'Ivoire	5,011.40	3.90	5.59	5.66	4.44
Eswatini	421.43	5.06	5.81	6.23	5.29
Gabon	1,471.68	5.32	3.14	3.57	1.76
Gambia	2,777.92	3.83	6.74	6.05	5.05
Ghana	3,724.07	6.03	5.71	6.24	5.41
Guinea	2,101.44	3.94	5.06	4.81	2.66
Kenya	4,038.09	4.86	5.27	6.03	4.31
Lesotho	616.91	3.96	5.02	6.04	5.04
Liberia	2,586.80	3.54	5.31	6.10	4.13
Malawi	1,422.66	3.89	5.45	5.29	3.01
Mali	3,192.49	4.32	5.96	5.37	3.87
Mozambique	2,367.97	3.93	6.51	5.73	4.39
Namibia	2,670.77	4.44	5.87	7.00	4.56
Niger	780.84	3.76	6.59	5.27	3.83
Nigeria	4,182.95	5.68	4.15	5.33	3.69
Senegal	5,352.21	5.84	6.78	6.07	4.45
Sierra Leone	4,375.99	4.17	6.15	6.69	4.74
South Africa	4,727.53	5.92	4.43	4.83	3.41
Tanzania	4,171.76	3.65	6.91	7.22	4.54
Togo	2,727.65	4.83	4.10	5.13	3.28
Uganda	1,643.82	3.92	5.97	5.70	3.96
Zambia	1,912.94	3.88	5.88	6.10	3.62
Zimbabwe	1,215.88	4.77	5.78	5.70	3.60

Table A.4: Correlation between population density and urban data points (2018 sample)

	Urban	Population density	Population density (log)
Urban	1	0.458	0.648
Population density	0.458	1	0.693
Population density (log)	0.648	0.693	1

Table A.5: Correlation between population density and urban data points (2015 sample)

	Urban	Population density	Population density (log)
Urban	1	0.448	0.515
Population density	0.448	1	0.644
Population density (log)	0.515	0.644	1

Appendix B: Governance indicators information

As part of its analysis of the effect that population density has on governance quality in sub-Saharan Africa, the study created four sub-national measures of governance quality: the infrastructure quality index (IQI), the institutional trust index (ITI), the rule of law index (RLI), and the satisfaction with government index (SGI). This appendix contains more information on the specific questions that were used to create these indexes, which were adapted from the Afrobarometer Round 7 survey.

Table B.1: Summary of infrastructure quality index questions

General question form: *"Are the following services/facilities present in the primary sampling unit/enumeration area, or within easy walking distance: [insert service/facility type]?"*	
R7 Afrobarometer question number	**Infrastructural service/facility name/type**
Q EA_SVC_A	Electricity grid
Q EA_SVC_B	Piped water system
Q EA_SVC_C	Sewage system
Q EA_SVC_D	Cell phone service
Q EA_FAC_A	Post office
Q EA_FAC_B	School
Q EA_FAC_C	Police station
Q EA_FAC_D	Health clinic
Q EA_FAC_F	Bank
Q EA_ROAD_B	Tarred/Paved road(s)

Table B.2: Summary of institutional trust index questions

General question form: *"How much do you trust each of the following, or haven't you heard enough about them to say: [insert institution]?"*	
R7 Afrobarometer question number	**Institution name/type**
Q 43A	President/Prime minister
Q 43B	Parliament/National Assembly
Q 43C	National Electoral Commission
Q 43D	Local government council
Q 43E	Ruling party
Q 43F	Opposition parties
Q 43G	Police
Q 43H	Army
Q 43I	Courts
Q 43J	Traditional leaders
Q 43K	Religious leaders

Table B.3: Summary of rule of law index question

General question form: *"In your opinion, how often, in this country: [insert violation of the rule of law]?"*	
R7 Afrobarometer question number	**Violation of the rule of law**
Q 39B	President ignores courts and laws
Q 39C	President ignores Parliament
Q 42D	Unequal treatment under the law
Q 42E	Officials go unpunished after breaking laws
Q 42F	Ordinary citizens go unpunished after breaking laws

Table B.4: Summary of satisfaction with government index questions

General question form: *"How well or badly would you say the current government is handling the following matters, or haven't you heard enough about them to say: [insert policy action area]?"*	
R7 Afrobarometer question number	**Policy action area**
Q 56A	Managing the economy
Q 56B	Improving the living standards of the poor
Q 56C	Creating jobs
Q 56D	Keeping prices down
Q 56E	Narrowing income gaps
Q 56F	Reducing crime
Q 56G	Improving basic health services
Q 56H	Addressing educational needs
Q 56I	Providing water and sanitation services
Q 56J	Ensuring everyone has enough to eat
Q 56K	Fighting corruption in government
Q 56L	Maintaining roads and bridges
Q 56M	Providing reliable electric supply
Q 56N	Preventing election violence
Q 56O	Preventing or resolving violent community conflict

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