Received: 21 March 2024 | Accepted: 26 December 2024

DOI: 10.1002/aepp.13510

FEATURED ARTICLE

AAEA Agricultural & Applied Economics Association WILEY

How do current and past mining activities affect water security, health, and economic opportunities?

Raymond Boadi Frempong[1] | **David Stadelmann**[2] | **Djiby Racine Thiam**[3]

[1]European School of Political and Social Sciences (ESPOL), Université Catholique de Lille, Lille, France

[2]University of Bayreuth, Bayreuth, Germany

[3]Water and Production Economics Unit, School of Economics, University of Cape Town, Cape Town, South Africa

Correspondence
David Stadelmann, University of Bayreuth, Bayreuth, Germany.
Email: david.stadelmann@uni-bayreuth.de.

Funding information
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation), Grant/Award Number: EXC 2052/1 - 390713894

Editor in charge: Gopinath Munisamy

[Correction added on 14 April 2025, after first online publication: The article classification has been updated in this version.]

Abstract

This paper investigates the effect of mining activities on health care, income and water deprivations in Africa. By combining household data with mining locations, we conducted an econometric analysis to assess the impact of mining on self-reported water security, health, and economic opportunities for 142,838 households. Our study utilizes the presence of active and inactive mines to measure the effects of household exposure to mining activities. We observe that proximity to active mining sites is associated with self-reported improved water security, access to health, and economic opportunities. Instrumental variable estimates support a causal interpretation of our results. Specifically, households located within a 50 km radius of active mines reported a 4% lower probability of lacking clean water. Our findings also reveal that robust local institutions not only enhance water security but also mitigate the negative health impacts associated with mine closures. These results suggest that strengthening local governance can amplify the potential benefits of mining operations. Therefore, we recommend the strengthening of local government institutions to foster the resilience of vulnerable mining communities.

KEYWORDS

Africa, health, livelihood, mining, poverty, WASH

JEL CLASSIFICATION

D7, L8

The World Health Organization's estimate that a third of Africans face water insecurity (WHO, 2023) underscores a critical public health concern, given the direct linkages between water, sanitation, and hygiene (WASH) and welfare indicators like health, education, income, and poverty. MacAlister et al. (2023) highlight that around 13 African countries are in a state of critical water insecurity, a situation that could be exacerbated by other existing conditions such as growing urbanization, expansion of mining activities, climate change, water pollution, etc. These conditions could derail the continent's progress toward achieving the Sustainable Development Goals.

In this context, our paper delves into the impact of mining operations on water security, health, and income opportunities in Africa while also examining the role of local governance in this dynamic. Mining plays a significant role in many African economies, contributing approximately 28% to GDP, and minerals represent between 30% and 70% of the continent's total exports (AFDB & ANRC, 2016; Signé & Johnson, 2021). Several African countries are well endowed with mineral resources (i.e., copper, diamond, gold, iron, silver, uranium, etc.), representing critical inputs to manufacturing industries, mainly outside the continent. While providing employment and supporting local communities through WASH projects, the mining sector's interaction with water resources, in particular, poses water security and health risks (Kunz, 2020). The industry's reliance on water for operations like dust suppression, equipment washing, and cooling could pollute surface and groundwater, posing direct and indirect health risks. Water pollution through acid mine drainage (AMD) is also a frequent negative effect associated with weakly regulated mining practices. From exploration to closures, mining operations have tangible impacts on water security, health, and income generation opportunities.

The impact of mining on water security, health, and economic outcomes presents a complex and multifaceted challenge. Unsurprisingly, mineral extraction is often associated positively with water pollution in developing countries but also in developed regions (Cianciolo et al., 2020; Kang et al., 2024; Mhlongo et al., 2018). At the same time, some studies suggest that mineral resource extraction can exacerbate economic challenges, including poverty and inequality (e.g. Brückner, 2010). Nevertheless, other research focusing on economic outcomes offers more positive prospects, indicating that there are potential poverty-reducing and employment effects of resource extraction (Ekanayake et al., 2023; Gollin et al., 2016). Microlevel studies from different countries and regions suggest that mining activities can positively influence poverty alleviation and have positive effects on health and job creation (Chavez, 2023; Fisher et al., 2009; Ge & Lei, 2013; Yadav et al., 2019). Dietler et al. (2021) highlight the link between mining and enhanced access to water and sanitation facilities. Cossa et al. (2022) suggest a nonlinear effect of mining on child health, with initial improvements overshadowed by later-stage insecurity and pollution. Diallo (2023) notes declining welfare post-mine closure, showing the need for sustainable community support. Bertinelli and Bourgain (2023) also document that residents in mining communities have a sense of structural disadvantage. Social trust is also negatively affected by large-scale land and mining investments in Africa.

We contribute to the existing literature by examining the effects of both active and inactive activities on individual welfare indicators (Dietler et al., 2021; Wegenast & Beck, 2020), specifically focusing on water quality, health, and income opportunities in Africa. We hypothesize that conditional on other covariates of household welfare, mining activities in the vicinity of households may increase income-generating opportunities. Notwithstanding, the impact of mining on water security and health is ambiguous. On the one hand, mining poses challenges related to pollution and potential direct health effects. On the other hand, investments and general economic improvements driven by mining activities may also improve water security and health, at least, as experienced by nearby households (Syahrir et al., 2021). We expect that mining activities in areas with strong local government institutions will yield more positive outcomes. This aligns with recent findings by Konte and Vincent (2021), who explored the local effects of mining on the quality of public services and residents' optimism about future living conditions in Africa, highlighting the moderating role of local institutions. Their results suggest that residents of mining communities that exhibit low corruption levels experience the highest rates of positive approval. Our study aims to systematically deepen the understanding of these dynamics by focusing on the microlevel impacts of mining on self-reported measures of water security, health, and income thereby adding a new perspective to the existing literature.

An additional contribution of our paper is its household-centric approach, utilizing lived experiences of scarcities—water, medicine (health), and income—as indicators of overall household well-being. Thus, we explore the effects of mining on three welfare indicators. We argue that these self-reported variables provide an accurate reflection of the actual deprivation experienced by households. Leveraging a large sample of 142,838 households across Africa in 2005 and 2015, we investigate the impact of active mines in the vicinity of households on self-reported access to clean water, and medicine, as well as whether households have gone without income. We also compare the results for active mines with those for inactive mines. Additionally, we place significant emphasis on the role of local governance and institutions, which prove to be relevant in our analysis.

Our empirical analysis reveals that proximity to active mining sites is associated with enhanced water security, better access to health care, and increased economic opportunities. These findings remain robust even after controlling for factors such as employment status and whether a household is located in an urban area. However, the effect is lower and sometimes insignificant when mines become inactive or are located farther from the household (50–100 km). We also observe a decline in self-reported water security when mines cease operations or are situated at greater distances. The positive effects of mining on income opportunities persist even after mines cease operations, indicating that mining can have longer term benefits for income generation. The use of instrumental variable estimates supports a causal interpretation of these relationships. By integrating this household-level data with specific locations of mining operations, our analysis offers a more detailed and rebust examination of the relationship between mining and its effects on household welfare. This approach allows us to shed light on the direct implications of mining activities on water security, health, and income.

Furthermore, we contribute to the literature on the importance of institutions for household welfare in Africa by examining the role of local institutional quality as perceived by household members themselves. Existing evidence suggests that institutional quality may moderate the impact of mineral resources on national poverty (Kansheba & Marobhe, 2022; Oluwaseyi Musibau et al., 2022). This means that the quality of local governance may be relevant in moderating the effects of resource extraction on community livelihoods. Local officials, due to their proximity to mining activities, are key in enforcing environmental regulations and addressing mining-related community problems. Furthermore, the effectiveness of local governance may affect the management and sustainability of essential services and infrastructure, including water and health facilities. Diallo (2023) and Syahrir et al. (2021) advocate for enhanced collaboration between mining companies and regional governments for post-mining sustainable community development to prevent the reversal of secured economic and social benefits that took place during operations. Our results, based on Afrobarometer surveys, show some moderation effects between active mining operations and local institutions, in particular, active mines may help to reduce the negative effects of local corruption on water security, health, and incomes.

In the subsequent sections we first discuss the data and the empirical strategy. Then we show how proximity to active and inactive mines affects water security, access to health, and economic opportunities. Next the analysis is extended to investigate the effect of local institutions. The last section offers concluding remarks.

DATA AND EMPIRICAL STRATEGY

Data

Our study merges two data sources to obtain a unique dataset to explore the effect of mining on water security, health, and income.

First, we obtain individual socioeconomic data from the Afrobarometer surveys. The Afrobarometer surveys, conducted repeatedly across Africa, gather public opinion, perceptions of welfare as well as deprivation indicators which are all self-reported. These surveys provide consistent data on individual responses to questions related to water security, access to health, and whether individuals have gone without income. We utilize data from survey rounds three to six (2005–2015), chosen for their consistency which allows us to address our research questions. Our household data is geo-coded (see also Wild & Stadelmann, 2022) so that we can establish where households live. This allows us to merge data from Afrobarometer consistently with our second data source.

We obtain mining location information from the Africa-PowerMining project (World Bank, 2018). The mining data comprises 435 records of mining operations across 28 African countries, sourced from the United States Geological Survey. The Africa-PowerMining project offers detailed information on each mining site, including the deposit name, location, and other key characteristics. This dataset categorizes mines based on the nature of their production activity and whether they are active producers or past producers.

We merge our geo-coded mining data with the geo-coded Afrobarometer data on households obtaining a dataset with up to 142,838 observations.

Dependent variables: Household water security, health, and income

We explore three different dependent variables that can all be seen as measures of deprivation (or conversely, individual well-being) as reported by the survey participants.

Our first dependent variable, household self-reported water security, is quantified using a binary measure. A value of one (indicating water insecurity) is assigned if a household has experienced a lack of adequate clean water at least once in the past 12 months.[1] During data collection, respondents indicated the frequency of water scarcity their household faced, ranging from "never" (0) to "always" (4). Those who reported "never" facing water scarcity are coded as zero, signifying clean water security. This measure is relevant as water security can be directly linked to health outcomes, with inadequate clean water access posing significant health risks.

Moreover, we examine the impact of mining activities on self-reported health. The health variable is structured similarly to the water security measure.[2] A household is considered deprived of health if it has gone without medicines or medical treatment in the last 12 months.

Finally, we also explore economic opportunities by investigating whether a household was marked by insufficient cash income in the last 12 months.[3]

Independent variables: Active and inactive mining operation

To assess the impact of mineral resource extraction on WASH and, more broadly, self-reported deprivation, we measure a household's exposure to active and inactive mining operations. More precisely, we create a 50 km buffer around each household in the Afrobarometer dataset and count the number of mining operations within this radius. We then extend this to a 50–100 km radius, forming two distinct exposure variables for our first analyses: (1) the number of mining operations within a 0–50 km radius, a standard distance used in Konte & Vincent. (2021), and (2) the number within a 50–100 km radius, ensuring these two ranges are mutually exclusive. This allows us to investigate the relationship between the concentration of mining activities and self-reported welfare. We hypothesize that the effects of mining on household water security may vary with distance. While mining can lead to environmental pollution in a wider area, the benefits, such as employment and access to health projects, might mainly benefit those in closer proximity to mines.

We also investigate inactive mines as an additional independent variable and compare the results across our different dependent variables for both active and inactive mines. The influence of mining on self-reported water security may also be contingent on the operational status of the mines. Both active and inactive mines pose risks of polluting nearby water sources. However, the community's capacity to mitigate these effects would be a function of the status of the mines. Active mines might offer employment, enabling residents to afford clean water, and companies might directly invest in WASH projects. In contrast, these benefits often disappear when mines close their operations, leaving communities vulnerable to ongoing environmental hazards like wastewater spillage or AMD. Therefore, distinguishing between active and inactive mines allows us to differentiate these varying impacts on water security and overall community well-being.

Descriptive statistics

We systematically account for a range of control variables in our empirical analysis, including schooling, whether a household resides in an urban area and employment status. This allows us to isolate the effect of active and inactive mines in the vicinity on our dependent variables of interest.

Table 1 presents an overview of the variables used in our analysis and gives relevant descriptive statistics. A list of countries included in our dataset is provided in Table A-XIII in the Appendix. The incidence of perceived water poverty/insecurity is about 36% in the sample. About 38% of households reported not having access to medicine and medication, and income levels were perceived as inadequate for about 65% of the sampled households. Regarding mines, there are 0.27 mines in the 0–50-kilometer radius of a household and there is on average more than one mine in the 0–100 km radius of a household. There are more active (0.24) than inactive (0.03) mines in the immediate vicinity (0–50 km) of the household. About 39% of households in the sample are in urban areas. We also account for basic infrastructure variables in the vicinity, as these may impact the self-reported dependent variables related to water security, health, and income. Additionally, since these infrastructure variables might be influenced by mining activities, we aim to ensure that our estimated effects of mining are independent of such basic infrastructure factors by accounting for them in the empirical analysis.

TABLE 1 Descriptive statistics.

Variable	Mean	SD	Min	Max
Dependent variables				
Household gone without clean water	0.36	0.48	0.00	1.00
Household gone without medicines (or medical treatment)	0.38	0.49	0.00	1.00
Household gone without a cash income	0.65	0.48	0.00	1.00
Independent variables (controls)				
All mines within 50 km radius	0.27	1.39	0.00	32
All mines within a 50–100 km radius (ActiveMine)	0.79	3.30	0.00	52.00
Active mines within a 50 km radius	0.24	1.15	0.00	22.00
Inactive within a 50 km radius	0.03	0.39	0.00	13.00
Secondary school	0.49	0.50	0.00	1.00
Urban residence	0.39	0.49	0.00	1.00
The community has paved roads	0.47	0.50	0.00	1.00
Market in the primary enumeration unit	0.63	0.48	0.00	1.00
Clinic in the primary enumeration unit	0.58	0.49	0.00	1.00
Piped water in the primary enumeration unit	0.54	0.50	0.00	1.00
Electricity in the primary enumeration area	0.60	0.49	0.00	1.00
Male respondent	0.50	0.50	0.00	1.00
Age of respondent	36.98	14.61	18.00	130.00
Respondent is employed	0.37	0.48	0.00	1.00
Regional corruption (local councillors) score	2.39	0.37	1.18	3.66
Regional corruption (tax officials) scores	2.43	0.35	1.17	3.78
Region local disapproval score	2.50	0.35	1.14	3.81

Note: Own calculation, computed from the dataset with Afrobarometer 3–5 (2005–2015) and Africa-PowerMining project.

Regarding demographics, there are as many males as female respondents in the sample. On average, less than half (48%) of the sample have secondary school education. While most households live in rural areas, coverage of social amenities and infrastructure like markets, clinics, piped-borne water, and electricity is more than half of the population. For example, 59% of households have access to electricity, 54% have access to piped water, 63% live in communities with markets, and 58% live in communities with clinics.

The indicators of regional institutional quality variables are a 1–4 scale where 4 represents the worst score. Table 1 shows that for all three indicators, the average in the sample is greater than two. This means that respondents tend to score their local government as somewhat corrupt and exhibit a sentiment of disapproval toward their representatives. For instance, the disapproval score is 2.5 which is 0.5 points higher than the theoretical mean of 2.0.

Empirical strategy

We explore the effect of active and inactive mines on our main dependent variables water security, health, and gone without income. Our main estimation equation is a linear probability model, stated as follows:

$$WS_{it} = \alpha + \beta_1 ActiveMine_{it} + \beta_2 InactiveMine_{it} + \boldsymbol{IND}'_{it}\boldsymbol{\beta} + \boldsymbol{PSU}'_{it}\boldsymbol{\Theta} + \mathrm{C} + \mathrm{t} + \epsilon_{\mathrm{i}}$$

WS represents the household's *i* at time *t* welfare/deprivation indicator (gone without clean water, medicine, and income). *ActiveMine* indicates the number of active mines within a specified geographical area near household *i* while *InactiveMine* indicates the number of inactive mines in the same area near household *i*. We also vary the vicinity of the mines, that is, we explore active (closed) mines in a vicinity of a 50 km radius as well as a 50-100 km radius jointly. *IND* is a vector encompassing individual-level characteristics of the respondent, including for example at least secondary education and employment status. The vector *PSU* includes community-level controls, and *C* and *t* represent country and time-fixed effects, respectively. By including country and time-fixed effects we aim to capture the aggregate effects of, for example, macroeconomic shocks. Control variables represent all variables listed in Table 1.

We aim to investigate the impact of active and inactive mine proximity on water security, health, and income. The literature presents mixed expectations regarding the sign of this coefficient with respect to our indicators. On one hand, studies like Wegenast and Beck (2020) have identified the negative impacts of mining on food security among women in Africa. Additionally, mineral resource extraction might lead to environmental degradation, such as water pollution and deforestation, potentially impairing access to water and fuel. On the other hand, the mining sector is a major employer in Africa, suggesting that proximity to mines could boost household earnings. Mines may also stimulate local economic activities through backward and forward linkages, thereby positively influencing the local economy. As a result, the effect of active mines cannot be predetermined and must be examined empirically. In fact, while mining may lead to potential environmental damage, it is also possible that access to clean water increases in the vicinity due to investments made in the area by mining operators. Similarly, inactive mines may continue to pose challenges for water security while likely no longer providing economic opportunities.

Regarding empirical identification, we acknowledge potential measurement errors in the mining variables. Our dataset primarily includes only registered commercial mines, but small-scale and unregistered mining operations are also widespread in many African countries which may affect the interpretations of our results. Such unregistered operations can also impact water security and household welfare. Many unregistered mines are often in the vicinity of registered mines as this is where mineral resources exist. This fact also informs our identification strategy. To address endogeneity issues, we focus on the number of mineral deposits in the area and use this variable as an instrument for active mines. We use mineral deposits in the 0–50 km radius of a household as well as mineral deposits in the 50–100 km radius as instruments for the main explanatory variables (active and inactive mines, and mines within 0–50 km and 50–100 km) in their respective models. The mineral deposits data is accessed from USGS (2023) and comprises deposits of major nonfuel mineral commodities. Our instruments satisfy the requirements for identification: Mineral deposits are linked to active mines, so the instruments are relevant predictors of active mining activity. At the same time, mineral deposits themselves are unlikely to affect water security, health, and economic opportunities directly or via other variables as such the exclusion restriction is likely to be fulfilled. Thus, mineral deposits are expected to affect water security, health, and income of households through mining activities allowing us to identify the causal impact of mining on these variables. We estimate the effects of mining activities on lived poverty with the Linear Probability and the Two-Stage Least Squares model for easier interpretation. We show in Table A-X (See Appendix) that the main results are quantitatively and qualitatively similar to the average marginal effect obtained from the Logit estimator.

THE EFFECT OF ACTIVE AND INACTIVE MINES: EMPIRICAL EVIDENCE

Table 2 explores the effect of mining activities on household self-reported water security, access to medicine during illness, and income. We measure exposure to mineral extraction with the number of mining operations within the household's 0–50 km and 50–100 km radii. We directly address potential endogeneity with a two-stage instrumental variable model. The Kleibergen–Paap rk LM statistic for the models indicates that they are identified, and the instruments are relevant. Moreover, the Kleibergen–Paap rk Wald test has an F-statistic of 13.044 which suggests the instruments are not weakly correlated with the endogenous variables in all our estimates. The table shows that mining operations have significant (causal) impacts on the three dependent variables related to WASH. The effects vary with the distance to the active mining sites. A concentration of mining activities within a 50 km radius of the household improves living standards in the dimensions of access to water and medicine. A mining operation within 50 km reduces the probability of water insecurity and the probability of going without medicine. However, exposure to mining activities within this radius appears not to have no significant effect on household income poverty in the sample.

Mining operations within a 50–100 km radius increases self-reported deprivation with respect to clean water. A possible reason for this is that mining companies sometimes mitigate the polluting effects of their activities with community water projects which usually serve households and individuals in their immediate vicinity. However, the adverse effect of mining may spread beyond the immediate catchment areas. It is possible that an upstream operation could pollute downstream waters for a considerable distance. Thus, while households in proximity could have access to clean water because of the community social project, those in distant locations may not have access to these interventions. For income poverty, the results in column 3 indicate that an additional mine in the 50–100 km radius reduces the probability of having

TABLE 2 Two-stage least square estimates of the effects of mining operations on water security, health, and income (only active mines).

	(1) Gone without water	(2) Gone without medicine	(3) Gone without income
All mines within 50 km radius	−0.036***	−0.016***	−0.006
	(0.005)	(0.005)	(0.006)
All mines within 50–100 km radius	0.005***	−0.000	−0.006***
	(0.002)	(0.002)	(0.002)
Country fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Household controls	Yes	Yes	Yes
Community controls	Yes	Yes	Yes
N	142,838	142,838	142,838
Kleibergen–Paap rk LM statistic	8.769	8.769	8.769
	[0.003]	[0.003]	[0.003]
Kleibergen–Paap rk Wald F statistic	13.044	13.044	13.044

Note: Robust standard error estimates are in parentheses. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$. Individual controls: respondent's age sex and secondary school and employment status. Community controls: urban dummy, dummies for piped water, electricity, clinic market. The complete estimation results are presented in Table A-I in Appendix.

inadequate income, while the effect of a closer mine is statistically insignificant. We believe this finding could be explained by the nature of our mining sample, which consists of registered formal companies only. The reality of mining operations is that there are usually small-scale unregistered mining operations outside the concessions of the registered companies. There is a likelihood for the activities of these small-scale artisanal mines to directly impact incomes in the communities. Potentially, this effect could be higher, especially if the large-scale registered mines operate in an "enclave" with minimal linkages with the surrounding communities.

It is important to highlight that our results remain robust both with and without the inclusion of the large array of controls that we account for. Notably, our results regarding the effect of mines on self-reported measures for water security, health, and income are not influenced by whether individuals reside in more densely populated areas, as captured by our urban versus rural dummy variable. Urban settings are often assumed to have better infrastructures, including water and medical supplies. We also account for basic infrastructure within the enumeration area where the household is surveyed, such as the presence of a clinic or piped water. Crucially, our findings persist even when these controls are not included.

Table 3 provides further relevant insights by disaggregating the mines according to their activity status, that is, the number of active and inactive (closed) mines in a vicinity of 50 km of a household. In these models, we employ the number of nonfuel deposits within 0–50 and 50–100 km as instruments for the two endogenous variables. First, the observation in Table 2 remains robust in these models too. Mining operations enhance household WASH by reducing water, medicine, and income poverty in the immediate communities. Focusing on household income, we further note that even though active and inactive mines are associated with lower monetary poverty, the poverty-reducing impact is larger for inactive mines. This result supports

TABLE 3 Evidence from two-stage least square estimations: Effects of mines of on water security, health, and income—comparing active versus inactive mines.

	(1) Gone without water	(2) Gone without medicine	(3) Gone without income
Active mines within 50 km radius	−0.027***	−0.016***	−0.018**
	(0.005)	(0.004)	(0.009)
Inactive within 50 km radius	0.072	−0.022	−0.154*
	(0.117)	(0.067)	(0.083)
Country fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Household controls	Yes	Yes	Yes
Community controls	Yes	Yes	Yes
N	142,838	142,838	142,838
Kleibergen–Paap rk LM statistic	2.965	2.965	2.965
	[0.085]	[0.085]	[0.085]
Kleibergen–Paap rk Wald F statistic	7.716	7.716	7.716

Note: Robust standard error estimates are in parentheses. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$. Individual controls: respondent's age, sex, and secondary school and employment status. Community controls: urban dummy, dummies for piped water, electricity, clinic market. The complete estimation results are presented in Table A-II in Appendix.

our explanation that in the absence of large, registered, and regulated companies, small-scale artisanal miners operate in their stead. As an extension, their activities could have a more direct and higher impact on the income level in the communities.

We interpret these results as offering new insights into the existing literature. Firstly, the presence of both active and inactive mines appears to positively influence income generation opportunities, as individuals report lower probabilities of having gone without income. Furthermore, we observe that active mines are positively associated with self-reported water security and access to medicine. Households near active mines tend to show a lower probability of having gone without clean water or medicine. This may be because active mines, beyond generating employment opportunities—which we control for—may also influence the broader community and investment possibilities. While environmental impacts may still exist, access to clean water, as reported by individuals, seems to increase. On the other hand, inactive mines may pose a problem for perceived water security.

THE RELEVANCE OF LOCAL GOVERNANCE FOR THE EFFECTS OF MINING

We delve into the influence of local institutional quality on how mining activities impact water security, health, and income. In the realm of macroeconomic research, various studies have traditionally used indicators like trust, corruption levels, accountability, rule of law, democratic governance, and judicial independence to gauge institutional quality (Acemoglu et al., 2005;

Corradini, 2021; Nawaz et al., 2014). These studies have provided valuable insights into the broader implications of institutional frameworks.

However, a significant gap exists in the availability of such detailed institutional data at the subnational level, particularly in the African context. We tap into individual perceptions and opinions regarding the performance of local governments. The Afrobarometer surveys provide a unique lens into local governance, covering aspects such as perceived corruption, trust in local authorities, and their responsiveness to citizen concerns.

We construct a set of indicators to ascertain the quality of local government. These indicators are derived from regional average scores on perceived corruption and public approval of governance. These variables not only reflect the general perception of local governance but also provide a nuanced understanding of how these governance aspects interact with and influence the effects of mining operations on local communities, particularly in terms of water security.

We analyze the link between institutional quality on the different indicators in Figure 1 (The underlying regression results are presented in Appendix A-III–A-IV). The figure provides the coefficient of the respective institutional variables when explaining water security, health, and income. For the estimation of the coefficient, we employ the same model and control variables as in Table 2. We observe a significant link between institutional quality and all our dependent variables. We consistently estimate that institutional corruption increases the probability of water insecurity among African households. A unit increase in the corruption score for local councillors is associated with about 0.10 higher probability of water insecurity in our sample. Similarly, households have a 0.10 higher probability of inadequate medicine for unit in local councillor corruption and the probability of monetary poverty is also higher. Figure 1 shows a similar pattern for tax official corruption, only that, here we observe a higher effect on monetary poverty. As an indicator of the overall performance of local government, local government disapproval is also associated with poorer WASH outcomes – higher water insecurity and

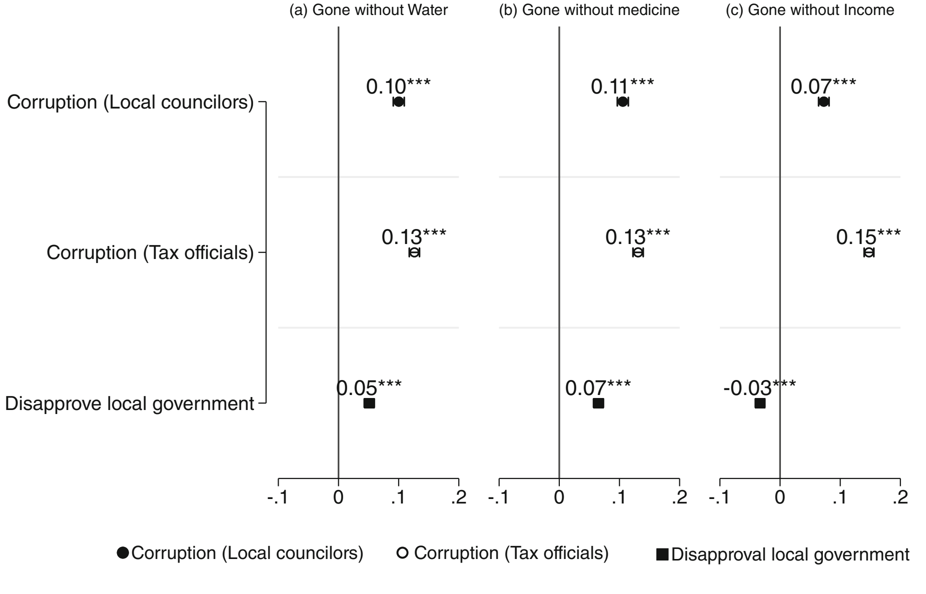

FIGURE 1 Effect of local government quality on WASH.

health poverty. However, we find that the local government disapproval score is associated with low-income poverty.

Next, we explore the relevance of local institutions in the mining-WASH nexus by introducing interaction terms between our measures for perceptions of households regarding local institutions and mining operations. This approach allows us to better dissect the interplay between local institutional quality and mining activities, offering a more granular understanding of how institutional factors at the local level can modulate the impacts of mining on water security and, by extension, on the broader socioeconomic fabric of African communities. To keep the analysis tractable, we limit the results to active and non-active mines within a 50 km radius of the primary enumeration area. To conserve space, we illustrate the main findings from the analysis in Table 4 for corruption among local councillors.

In Table 4 (See Table A-VI for the complete results), we find that institutional quality moderates the effect of mining activities on household water security, health, and income in Africa. Active mining operation plays a higher role in improving access to water, that is, reducing water insecurity, and access to medicine and income, in regions with local councillors that are perceived to be less corrupt. Conversely, adverse effects of mining on water security, health, and income of inactive mines increases if local councillors are corrupt. This evidence is suggestive that mining operations can make up for problems related to corruption in the case of active mines. Indeed, without institutional support, mining communities deteriorate after the

TABLE 4 Mining operation and local councillor corruption: Analyzing moderation effects.

	(1) Gone without water	(2) Gone without medicine	(3) Gone without income
Active mines within 50 km radius	0.078***	0.033**	0.026*
	(0.011)	(0.010)	(0.012)
Corruption (local councillors)	0.106***	0.107***	0.073***
	(0.005)	(0.005)	(0.004)
Active mines within 50 km radius*	−0.035***	−0.017***	−0.015***
Corruption (local councillors)	(0.004)	(0.004)	(0.005)
Non-active within 50 km radius	−0.078*	−0.109**	−0.063
	(0.035)	(0.033)	(0.037)
Non-active within 50 km radius*	0.040**	0.047***	0.029*
Corruption (local councillors)	(0.013)	(0.013)	(0.014)
Country fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Household controls	Yes	Yes	Yes
Community controls	Yes	Yes	Yes
N	142,838	142,838	142,838
R^2	0.069	0.103	0.142

Note: Robust standard error estimates are in parentheses. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$. Individual controls: respondent's age, sex, and secondary school and employment status. Community controls: urban dummy, dummies for piped water, electricity, clinic market. The complete estimation results are presented in Table A-VI in the Appendix.

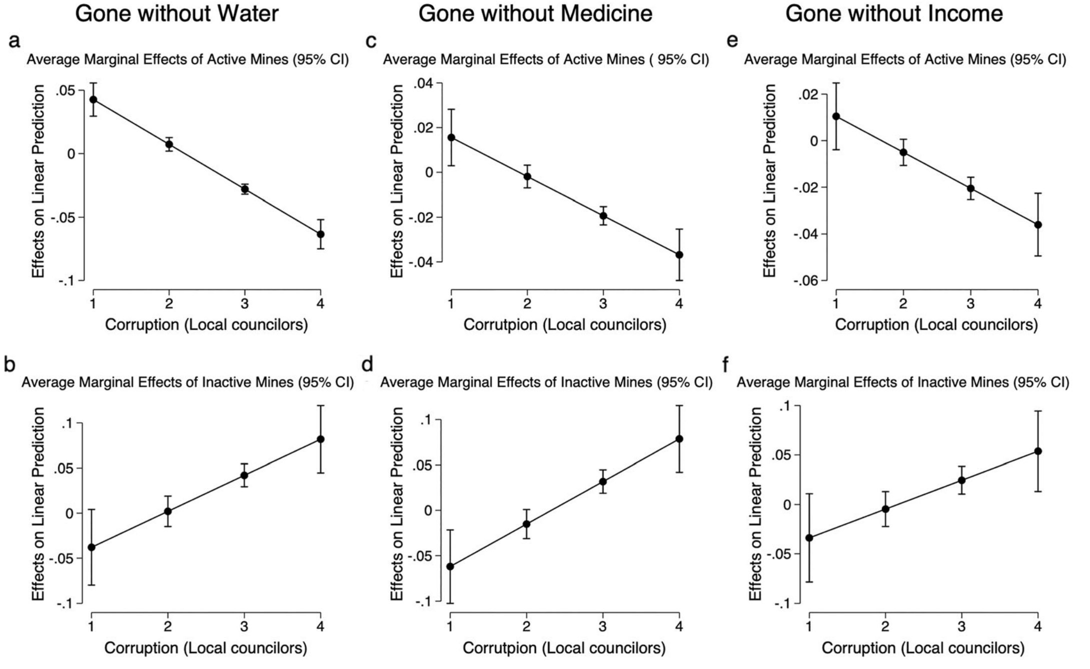

FIGURE 2 Moderation effects of local institutions on the effect of mining activities on WASH.

active life of the mine (Diallo, 2023; Syahrir et al., 2021). Once mines are inactive, the negative effects of local corruption seem to prevail. Figure 2 illustrates the results: active mining sites in the vicinity of a household decrease the likelihood of having gone without water, medicine, and income as perceived corruption increases while the opposite holds for inactive mines. Thus, active mining operations seem to help to reduce the negative effect of corruption.

The relationships and moderation effects found in Table 4 can also be observed for other institutional variables such as perceptions of corruption of tax officials and disapproval of local governance. Results for all other institutional variables are similar and we present them in the Appendix.

CONCLUSIONS

This paper examines the impact of mining operations on individual welfare, specifically in terms of self-reported water security, health, and income in Africa. Mining has been widely scrutinized in the literature for its potential dual role: while it can support local economies and community projects, it also poses risks to water resources and health due to potential pollution from operations. A common perception is that mining negatively affects access to clean water. However, whether these effects on clean water are substantiated when analyzing individual-level data remains an open research question. By employing a household-centric approach, we investigate the microlevel impacts of mining on self-reported water security and health across 142,838 African households from 2005 to 2015.

In line with the literature, we find evidence that proximity to active mining sites is associated with increased economic opportunities. Households report significantly lower probabilities of having gone without income when living closer to mines. Contrary to common perceptions, we also find evidence that self-reported access to clean water and medicine improves near active mines. However, these benefits diminish when mines close or as the distance from the mines increases. A possible explanation for these results is the reduction in community support that mining corporations typically provide to their surrounding communities during active operations. The lack of effective environmental management protocols after the closure of the mines may contribute to worsening water quality after operation.

Importantly, our investigation also underscores the critical role of local governance in the context of mining. Issues such as water insecurity, health shortages, and low incomes—partly stemming from deficiencies in local governance—are moderated by mining activities. In this way, we also emphasize the broader relevance of strong institutions, particularly in communities that tend to be comparatively vulnerable. In fact, strong local governance may reduce the likelihood of illegal mining activities in inactive mines which have been associated with negative environmental and health impacts.

In conclusion, while mining contributes significantly to African economies, its impact on water security and health is complex and influenced by local governance. Sustainable management and collaboration are essential to harness the benefits of mining while mitigating its risks and long-term impacts. The current study relies on registered and regulated mines, therefore the effects we observed could represent the lower bound of mining effects in WASH. Small-scale artisanal miners have been documented to step in after the closure of commercial mines. Due to a lack of monitoring and supervision, their activities have been reported to pollute large water bodies. Future studies could, therefore, focus on the activities of these small-scale miners using a similar empirical setup.

ACKNOWLEDGEMENTS

Raymond B. Frempong and David Stadelmann acknowledge funding from the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany's Excellence Strategy - EXC 2052/1 - 390713894. All authors thank the Rosenberg International Forum on Water Policy, the guest editors of the Special Issue: Unpacking Water Management Complexity in Agriculture in the Global South, and the two anonymous reviewers for helpful comments. Open Access funding enabled and organized by Projekt DEAL.

ORCID

Raymond Boadi Frempong https://orcid.org/0000-0002-4603-5570
David Stadelmann https://orcid.org/0000-0002-1211-9936

ENDNOTES

[1] The question employed is: Over the past year, how often, if ever, have you or anyone in your family: Gone without enough clean water for home use? [0–4].

[2] The question employed is: Over the past year, how often, if ever, have you or anyone in your family: Gone without medicines or medical treatment? [0–4].

[3] The question employed is: Over the past year, how often, if ever, have you or anyone in your family: Gone without a cash income? [0–4].

REFERENCES

Acemoglu, D., S. Johnson, and J. A. Robinson. 2005. "Chapter 6 Institutions as a Fundamental Cause of Long-Run Growth." In *Handbook of Economic Growth*, Vol 1, edited by P. Aghion and S. N. Durlauf, 385–472. Amsterdam: Elsevier. https://www.sciencedirect.com/handbook/handbook-of-economic-growth.

AFDB, & ANRC. 2016. Catalyzing growth and development through effective natural resources management

Bertinelli, L., and A. Bourgain. 2023. "Mining Revenues and Quality of Public Goods in Sub-Saharan Africa." *Journal of International Development* 35(8): 2253–68. https://doi.org/10.1002/jid.3773.

Brückner, M. 2010. "Natural Resource Dependence, Non-tradables, and Economic Growth." *Journal of Comparative Economics* 38(4): 461–471. https://doi.org/10.1016/j.jce.2010.06.002.

Chavez, C. 2023. "The Effects of Mining Presence on Inequality, Labor Income, and Poverty: Evidence from Peru." *Mineral Economics* 36(4): 1–28. https://doi.org/10.1007/s13563-023-00370-6.

Cianciolo, T. R., D. L. McLaughlin, C. E. Zipper, A. J. Timpano, D. J. Soucek, and S. H. Schoenholtz. 2020. "Impacts to Water Quality and Biota Persist in Mining-Influenced Appalachian Streams." *The Science of the Total Environment* 717: 137216. https://doi.org/10.1016/j.scitotenv.2020.137216.

Corradini, C. 2021. "Local Institutional Quality and Economic Growth: A Panel-VAR Analysis of Italian NUTS-3 Regions." *Economics Letters* 198: 109659. https://doi.org/10.1016/j.econlet.2020.109659.

Cossa, H., D. Dietler, E. Macete, K. Munguambe, M. S. Winkler, and G. Fink. 2022. "Assessing the Effects of Mining Projects on Child Health in Sub-Saharan Africa: A Multi-Country Analysis." *Globalization and Health* 18(1): 7. https://doi.org/10.1186/s12992-022-00797-6.

Diallo, P. 2023. The African Towns Falling into Decline and Poverty after Mining Companies Use Resources Then Exit Retrieved from https://theconversation.com/the-african-towns-falling-into-decline-and-poverty-after-mining-companies-use-resources-then-exit-69687

Dietler, D., A. Farnham, G. Loss, G. Fink, and M. S. Winkler. 2021. "Impact of Mining Projects on Water and Sanitation Infrastructures and Associated Child Health Outcomes: A Multi-Country Analysis of Demographic and Health Surveys (DHS) in Sub-Saharan Africa." *Globalization and Health* 17(1): 70. https://doi.org/10.1186/s12992-021-00723-2.

Ekanayake, P. N. S. P., J. B. Madsen, and T. Bharati. 2023. "Trade and Economic Growth: Does the Sophistication of Traded Goods Matter?" *Journal of Economic Growth* 28(4): 481–524. https://doi.org/10.1007/s10887-023-09224-w.

Fisher, E., R. Mwaipopo, W. Mutagwaba, D. Nyange, and G. Yaron. 2009. ""The Ladder that Sends us to Wealth": Artisanal Mining and Poverty Reduction in Tanzania." *Resources Policy* 34(1–2): 32–38. https://doi.org/10.1016/j.resourpol.2008.05.003.

Ge, J., and Y. Lei. 2013. "Mining Development, Income Growth and Poverty Alleviation: A Multiplier Decomposition Technique Applied to China." *Resources Policy* 38(3): 278–287. https://doi.org/10.1016/j.resourpol.2013.05.004.

Gollin, D., R. Jedwab, and D. Vollrath. 2016. "Urbanization with and without Industrialization." *Journal of Economic Growth* 21(1): 35–70. https://doi.org/10.1007/s10887-015-9121-4.

Kang, J.-K., Yungoo Song, Ji-Won Moon, and H.-S. Moon. 2024. "Water Quality Impact of Mining in the Wolmyoung Area of Korea, and its Short-Term Changes." *Water, Air, and Soil Pollution* 129: 349–367.

Kansheba, J. M. P., and M. I. Marobhe. 2022. "Institutional Quality and Resource-Based Economic Sustainability: The Mediation Effects of Resource Governance." *Sn Business & Economics* 2(2): 19. https://doi.org/10.1007/s43546-021-00195-x.

Konte, M., and R. C. Vincent. 2021. "Mining and Quality of Public Services: The Role of Local Governance and Decentralization." *World Development* 140: 105350. https://doi.org/10.1016/j.worlddev.2020.105350.

Kunz, N. C. 2020. "Towards a Broadened View of Water Security in Mining Regions." *Water Security* 11: 100079. https://doi.org/10.1016/j.wasec.2020.100079.

MacAlister, C., G. Baggio, and V. Perera. 2023. *Global Water Security 2023 Assessment*. Hamilton, Canada: United Nations University; https://unu.edu/inweh/collection/global-water-security-2023-assessment

Mhlongo, S., P. T. Mativenga, and A. Marnewick. 2018. "Water Quality in a Mining and Water-Stressed Region." *Journal of Cleaner Production* 171: 446–456. https://doi.org/10.1016/j.jclepro.2017.10.030.

Nawaz, S., N. Iqbal, and M. A. Khan. 2014. "The Impact of Institutional Quality on Economic Growth: Panel Evidence." *The Pakistan Development Review* 53(1): 15–31 Retrieved from http://www.jstor.org/stable/24397923.

Oluwaseyi Musibau, H., W. Olawale Shittu, and M. Yanotti. 2022. "Natural Resources Endowment: What More Does West Africa Need in Order to Grow?" *Resources Policy* 77: 102669. https://doi.org/10.1016/j.resourpol.2022.102669.

Signé, L., and C. Johnson. 2021. Africa's Mining Potential: Trends, Opportunities, Challenges and Strategies (No. PP-21/10)

Syahrir, R., F. Wall, and P. Diallo. 2021. "Coping with Sudden Mine Closure: The Importance of Resilient Communities and Good Governance." *The Extractive Industries and Society* 8(4): 101009. https://doi.org/10.1016/j.exis.2021.101009.

USGS. 2023. *Major mineral deposits of the world* Retrieved from https://mrdata.usgs.gov/major-deposits/

Wegenast, T., and J. Beck. 2020. "Mining, Rural Livelihoods and Food Security: A Disaggregated Analysis of Sub-Saharan Africa." *World Development* 130: 104921. https://doi.org/10.1016/j.worlddev.2020.104921.

WHO. 2023. Water Retrieved from https://www.afro.who.int/health-topics/water

Wild, F., and D. Stadelmann. 2022. "Coastal Proximity and Individual Living Standards: Econometric Evidence from Georeferenced Household Surveys in Sub-Saharan Africa." *Review of Development Economics* 26(4): 1883–1901. https://doi.org/10.1111/rode.12901.

World Bank. 2018. Africa – PowerMining Projects Database | Data Catalog Retrieved from https://datacatalog.worldbank.org/search/dataset/0040272/Africa—PowerMining-Projects-Database

Yadav, A. K., R. B. Bhagat, and V. Yadav. 2019. "Does Coal Mining Affect Household Food Security? An Empirical Study of Dhanbad, India." *Agriculture & Food Security* 8(1): 1–12. https://doi.org/10.1186/s40066-018-0244-7.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Frempong, Raymond Boadi, David Stadelmann, and Djiby Racine Thiam. 2025. "How Do Current and Past Mining Activities Affect Water Security, Health, and Economic Opportunities?" *Applied Economic Perspectives and Policy* 47(2): 586–601. https://doi.org/10.1002/aepp.13510