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# – MINERALIZED URBANIZATION IN AFRICA IN THE TWENTY-FIRST CENTURY: Becoming Urban through Mining Extraction

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**Abstract**

*This article focuses on the urbanizing impact of the post-millennial mineral boom at artisanal and small-scale (ASM) or large-scale (LSM) mining sites in three mineral-rich countries, involving gold in Ghana, diamonds in Angola, and both minerals in Tanzania. The focus is on comparing the agency of miners and other residents migrating to, settling in, and making the mining site habitable. Their mobility and settlement patterns reveal an urbanization trend marked by population agglomeration and expanding labour complexity, taking distinct forms at the rush and mature stages of gold and diamond ASM and LSM sites. Citing data from household surveys conducted at 12 mining sites, we trace how 'mineralized urbanization' propels in-migration, rising localized purchasing power, and proliferating service sector and trade activities, fuelling both urban demographic and economic change along the mining extraction trajectory. LSM and ASM generate synergies as well as detractive forces, depending on the size, age and history of the mining settlement development. What emerges is the differential development of households and settlements through strategic economic manoeuvring and the rough and tumble of happenstance, underlined by a compelling, albeit fluctuating, trajectory of non-renewable mineralized urbanization.*

## Introduction

In this article, mining settlements provide our lens for understanding the influence of gold and diamond production on the temporal and spatial patterns of urbanization in mineral-rich areas of Africa. Our focus is on unfolding migration and settlement configurations, in both industrial and artisanal sites, and the differential welfare of local residents. The demographic groundswell of miners and service providers migrating to local mining sites in Sub-Saharan Africa testifies to residents' expectations of beneficial outcomes (see Hilson, 2003, for Ghana; Jacques *et al*., 2007, for Burkina Faso; Jønsson and Bryceson, 2009, for Tanzania; Geenen, 2016, for the Democratic Republic of Congo; and Udelsmann Rodrigues, 2017a for Angola).

A dramatic rise in global mineral prices at the turn of the millennium set in train a series of demographic and economic transformations at large-scale industrial mining sites and artisanal sites, where thousands of people were congregated (Werthmann, 2000; Grätz, 2002; 2013; Lanzano, 2018). Mineral rush settlements surfaced and often reached the population size of small towns, while many existing large towns and regional cities became more populous. In other mining sites, the boom was short-lived, leading to out-migration triggered by downturns in mineral availability or declining prices.

We are grateful to the UK Department for International Development (DfID) and the Economic Research Council for funding (ESRC RES-167-25-0488). Thanks go to the key informants and miners and residents of our surveyed mining settlements in Angola, Ghana and Tanzania. We dedicate this article to our colleague and friend Professor Paul Yankson, who sadly passed away in early 2021.

Our analysis explores 'mineralized urbanization', defined as the catalysing effect of mineral discovery, production cycles and commodity chains on urban growth and settlement patterns at local, regional and national levels, in the context of oscillating booms and busts of global mineral markets and eventual mineral depletion (Bryceson and MacKinnon, 2012). Based on household survey data collected through the Urbanization and Poverty in Mining Africa (UPIMA) research programme,[1] this article documents urbanizing population agglomerations arising from migration, changing sectoral labour patterns, improved housing, and expanding domestic investment associated with mineral extraction at 12 gold and diamond sites in East, West and Southern Africa.

Adopting a comparative settlement approach, we track the changing nature and size of settlements as mineral availability alters over the course of gold and diamond mining, tracing how urbanizing mining settlements have coalesced, expanded or contracted as miners and non-mining residents devise viable livelihoods and form households on site. In addition, we interrogate the synergies between mining and urbanization to assess the local mining settlement populations' material development and well-being over the course of the rise and fall of the mineralization trajectory.

The next section reviews the literature on comparative urbanization, outlines our study's theoretical premises and summarizes our research methodology. The subsequent section provides historical background on the global mineral boom of 2000–2013 and the transformation of the case-study settlement sites. The fourth section delineates three stages in the development of mineral-producing sites and their distinguishable demographic characteristics and manifestations of urbanization. The fifth section reveals the degree of occupational change that occurred in the surveyed settlements during the period from the initial acceleration of the mining boom to just before its peak. The sixth section compares the differentially accruing material rewards of the mineral boom along the mineralization trajectory with respect to the residents' housing, material possessions and investment patterns. Welfare patterns between countries and between settlement types within each country are also identified and discussed. The penultimate section reviews residents' agency during the transitional process of mineralized urbanization. The final section concludes.

## Perceiving African mineralized urbanization

### – Literature review

It is striking that the voluminous literature on post-independence urban Sub-Saharan Africa during the latter half of the twentieth century (Little, 1960; O'Conner, 1983, Freund, 2007; Myers, 2011; Parnell and Pieterse, 2014) rarely mentions the role of mining as a catalyst for urbanization, despite the fact that the countries which first evidenced rising levels of urbanization were the mineralized economies of South Africa (Mayer and Mayer, 1961), the Rhodesian Copperbelt (Mitchell, 1954; Powdermaker, 1962), and the Belgian Congo (Freund, 2007). Since then, an impressive body of research on mining and urbanization in the Copperbelt has surfaced which traces the impact of the global mining boom in light of Southern Africa's long mining history (Mususa, 2012; Negi, 2014; Potts, 2015; Larmer *et al*., 2021). The more recent urbanizing experiences of mineral-rich East African countries during the 2000–2013 mineral boom testify to significant demographic growth and occupational change (Bryceson *et al*., 2012; Fafchamps *et al*., 2016; Jønsson and Bryceson, 2017).

1 For the UPIMA qualitative data analysis see Udelsmann Rodrigues and Bryceson (2018), Gough *et al*. (2019), and Bryceson *et al*. (2020). The UK Data Service repository link to the project is: https://beta.ukdataservice.ac.uk/datacatalogue/studies/study?id=850839. To download the files from the data repository, login is required: https://reshare.ukdataservice.ac.uk/850839/

This journal's online compendium of past articles on urban comparative analysis collated by Jennifer Robinson (2014) offers a wealth of case-study comparisons. In reviewing the literature, Robinson (2011) criticized the bi-polarization between North and South urbanism, while Bunnell and Maringanti (2010) bemoaned the literature's over-concentration on 'metrocentricity' that deflected attention from rural and urban processes of change in the global South. McFarlane (2010) argued for comparison as a strategy of critique in post-colonial and development studies aimed at inciting new lines of enquiry and a rethinking of existing typologies and methodologies. Despite these calls for change, however, the bulk of the comparative urban literature dwells on juxtaposing metropolitan cities in different national settings. Our study is positioned within three national contexts, but it is aimed at comparing the similarities and differences of urbanizing settlements both spatially and temporarily, ranging from rural greenfield sites to large urban towns, as a means of apprehending the interactive processes of urbanization and mining which were widely prevalent across the globe during the first two decades of the twenty-first century, particularly in Sub-Saharan Africa.

Over the course of 40 years, the urban sociologist Janet Abu-Lughod (1975; 2007) has refined a comparative evolutionary, but non-teleological, approach for discerning similarities and differences between urban areas, grounded in a sense of 'common process' rather than common origins. Taking the perspective that settlements 'become' rather than 'are' urban, Abu-Lughod provides rich empirical documentation of different routes to urbanism, exemplified in various parts of the world. Similarly, the geographer Gavin Bridge conceptualizes resources as a primary social category through which human beings organize their relationships with the non-human world, recognizing that materials 'become' resources in various 'need-to-have' contexts (Bridge, 2008). These insights are vital to the comprehension of mineralized urbanization, in which mineral discovery serves as a precursor to urban 'coalescence', conditioned by the continuing mineral supply to fuel a demographic and economic transformation of sufficient magnitude and form to *become* an urban settlement. Tracing processes of 'becoming urban' is hence more revealing than over-specifying and essentializing common characteristics between urban areas that are bound to alter, given the likelihood of frequent and rapid rates of change in mining settlements. In this article we define urban settlements as populations of over 10,000 with diversified occupational divisions of labour that differ from the surrounding agrarian countryside.[2]

## – Analytical concepts

Mining settlements' futures are fundamentally uncertain in relation to the quantity and quality of mineral deposits. The fluctuation of mineral market prices can cause soaring in-migration or stagnation, decline or disappearance. Ultimately, the excavation of non-renewable minerals diminishes and gradually ceases to fuel the settlements' demographic and economic growth. In other words, mineralized urbanization is not a unilinear trajectory. The residents of mining settlements are continuously subject to fluctuating economic stimuli.

The 'mineralization' process refers to the land, labour and capital directly and indirectly involved in mineral production and the associated trade and services which engage the efforts of mining settlement residents linked to wider local, regional and global networks of value exchange. It encompasses the expansion of large-scale industrial (LSM) and/or artisanal and small-scale mining (ASM), which is mostly reliant on hand-held tools at depths generally not exceeding 50–60 metres, digging in the deeper tunnels of previous LSM excavations or, alternatively, covertly processing LSM surface tailings.[3]

2 See Potts (2018) for a discussion of urban definitions in Sub-Saharan Africa.
3 Mine tailings consist of leftover unprocessed ore at the mining site.

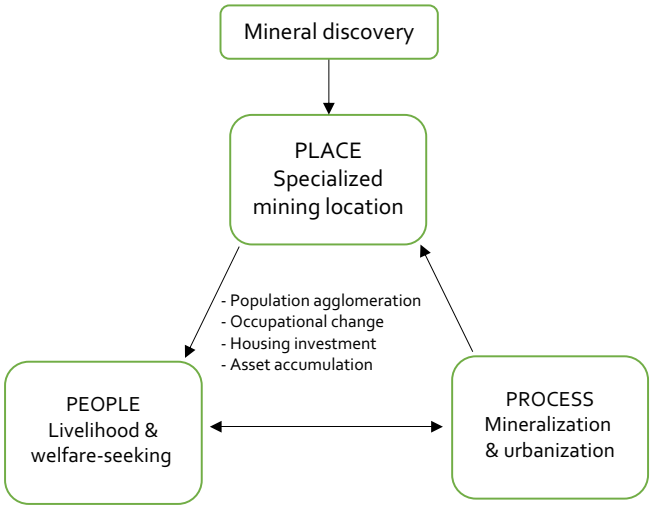


**FIGURE 1** The dynamics of mineralized urbanization (*source*: authors' research)

Relative to LSM, ASM absorbs far more labourers and enhances the local economic multiplier effect (Bryceson and Jønsson, 2014). The interlocking influences of ASM and LSM are both complementary and contradictory in nature throughout Sub-Saharan Africa at present. Over the longer term, however, artisanal miners tend to be eclipsed by LSM, or they are displaced by medium-scale machine-reliant operators (Bryceson *et al*., 2020).

The interaction between processes of mineral extraction and urbanization is key. The process of mineralized urbanization is catalysed by mineral discovery and/or rising global mineral prices through which ASM or LSM become profitable. The rising global mineral prices spur the momentum of population agglomeration and the proliferation of the local division of labour, fuelling economic growth. The duration of the economic upswing is indeterminate in view of the uncertainty over the quality and depth of the mineral deposits and the choice of mining technology. Figure 1 represents a stylistic portrayal of the dynamics of mineralized urbanization. Every forward movement is largely conditional on the degree of value creation of the extracted minerals in view of the non-renewable nature of the mineral supply and its price fluctuation.

Political contestation may ensue, depending on what type of minerals are being produced, who owns and controls the minerals, and how the minerals are mined. Alliances between nation-states and global corporations overwhelmingly opt for LSM production. This is counterposed by the interests of people pursuing ASM, with household livelihood imperatives.

Abu-Lughod (1975) warns against early urban comparative thinking which assumes that a single prime mover, specific cultural traits, traditions or features of settlement can be discerned as the central driver of change. In the case of mineralized urbanization, the continuation of the mining process in some form or another constitutes a necessary condition for on-going urbanization. While not singularly determinant, mining is temporally and spatially delimited, and does not provide any certainty of mineral output from one day to the next. Furthermore, Abu-Lughod stresses the need to identify differences. Comparative urban studies should first stipulate the contextual parameters, by identifying the variables that are roughly constant before identifying distinguishing variables, and then trace processes of *becoming* (rather than assuming a static state of *being*) urban.

Abu-Lughod (1975) argues that identifying a general 'urban process' entails explaining: (1) the contextual conditions; (2) the relationship between processes of concentration and dispersion, and the mechanism whereby differential valuations and settlement decisions are cumulatively translated into centripetal or centrifugal movements that are revealed in site comparisons; (3) the conditions under which, and the processes whereby, social structures are translated into spatial patterns; and (4) shifts in the core-periphery balance over time under conditions of changing patterns of transportation, communication, and distribution mechanisms for money and power.

There is no ideal type of an urbanizing mining settlement. What exists is a wide continuum of mining settlement characteristics contingent on the size of the mineral supply and the intensity and duration of extraction. What is nonetheless apparent is that mining settlements evolve similar distinct patterns along the mineral extraction trajectory. We therefore chose sites for comparison that were representative of the three stages of this trajectory, as explained below.

– Comparative research methodology

Making sense of the uncertain, multi-dimensional and multi-scalar nature of the entwined processes of mineralization and urbanization necessitates a comparative place-based research methodology to disentangle the temporal phases and spatial patterns of mining-induced demographic and economic change. Our study was a tiered investigation based on the delineation of: (1) minerals: gold and diamonds; (2) case-study countries: Tanzania, Ghana and Angola; and (3) mining settlement types: early artisanal rush settlements, mature artisanal settlements, and large-scale industrial urban mining settlements. The comparison of artisanal sites at their embryonic and mature stages affords significant insights into the place-based progression of the mining cycle.

Field data collection was carried out between May 2011 and July 2012, beginning with the selection of 12 study sites, evenly divided between gold sites (in Tanzania and Ghana) and diamond sites (in Tanzania and Angola). Macroeconomic and demographic analysis relies heavily on published official labour statistics and census data. Consequently, the presence of artisanal mining, which is casualized, spatially mobile, and temporally in flux, is often overlooked by statisticians in African countries. For this reason, purposive quantitative survey sampling and qualitative interviewing are vital to recording the incidence and nature of artisanal mining.

At the outset, the country teams interviewed key informants, who encompassed elderly residents as well as government officials and local leaders at the mining sites and district/regional headquarters. Either the local language, English or Portuguese were used according to informants' preferences. Stratified random sample surveys were conducted in 702 households at the 12 sites: half were living in the densely populated central core of the settlement and the other half on the settlement perimeter in the direction of the mining. Random selection resulted in a mix of mining and non-mining heads of household.

## The twenty-first century global mineral boom and country mining trajectories

Buffeted by the surge in the international price of oil during the 1970s, Sub-Saharan Africa experienced decades of peasant smallholder involution and de-agrarianization, leading to massive rural labour displacement (Bryceson, 1996; Ellis and Freeman, 2005). Rural households' farm labour time decreased and the coherence of the household as an agricultural production unit weakened, replaced by the more individualized off-farm economic diversification of family members. The scramble for non-agricultural sources of income led to a proliferation of occupational pathways. By far the most lucrative was artisanal mining, which increased in the 1990s

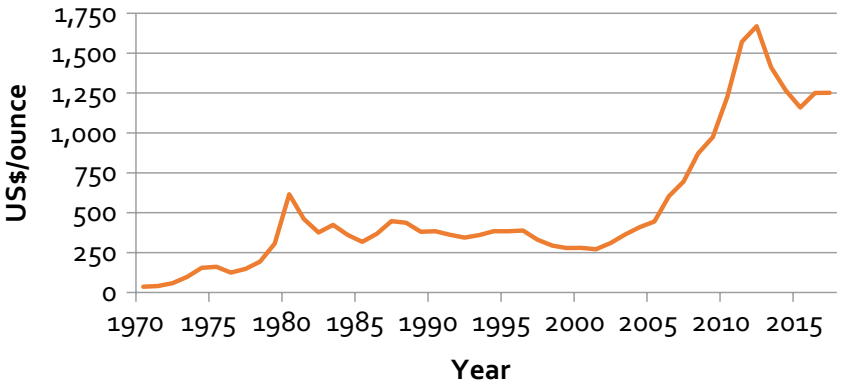


**FIGURE 2** International gold price, 1970–2017 (*source*: www.kitco.com)

and boomed in the 2000s in response to the surging price of minerals and metals in the global market, especially gold's meteoric price rise (see Figure 2).[4] Hayes (2008) estimates that there were approximately nine million miners engaged in African artisanal mining with an additional 54 million people indirectly dependent on the sector. Given the fluidity of migrant artisanal miners, such an estimate must be viewed as purely indicative.

African economic growth rates rose between 2000 and 2013,[5] stimulated by an international mineral boom that was especially evident in the gold price spiral. The escalating importance of mining became instrumental in altering both the form and content of the continent's demographic and economic foundations (Bryceson and Jønsson, 2014). The growth of ASM and LSM mining populations, the occupational expansion of the non-mining population, and the associated growth of the settlements' service sectors are integral to understanding the entwined synergy of mineralization and urbanization reflected in our site findings.

National contexts heavily influence the nature of mineralized urbanization in the surveyed countries. Both Angola and Ghana became middle-income countries between 2000 and 2013, whereas Tanzania remained low-income. Their respective annual gross national income growth rates in 2013 were 6.4%, 10.8% and 6.7% (World Bank, 2020). Distinctive historical mining trajectories have evolved in the three countries with respect to their colonial/post-colonial heritage, the presence or absence of war, gold as opposed to diamond exports, and the relative scale and nature of ASM production compared to LSM. At the local level of the surveyed sites, the age of the mining settlement and the dominance of indigenous or migrant populations also matters.

During the peak of the millennial mineral boom (2010–2013), the rising value of gold far exceeded that of diamonds. The world price for gold exhibited a pronounced escalation from 2005, peaking in 2012. Artisanal gold miners had an acute awareness of the international gold price, informed daily by the internet, whereas the price of diamonds varied enormously, requiring on-the-spot expert value assessment. Artisanal diamond miners were subject to being misled by traders and brokers about the true value of their diamond output. We found no records of artisanal gold and diamond sales, precluding accurate estimates of artisanal output. Information on gold output, however, can be gleaned from the International Council of Mining and Metals (ICMM, 2012) comparative country data on LSM formal mineral output, which registered the value

4 The international gold price resurged in 2020.
5 GDP annual per capita growth for the periods 1990–2000 vs 2000–2013 were as follows: Sub-Saharan Africa -0.6 vs 2.5; Angola -2.0 vs 4.3; Ghana 1.6 vs 4.2, and Tanzania 0.0 vs 3.5 (World Bank, 2020).

of production in 2010 as follows: Ghana US $3.96 billion, marking a 290% increase since the turn of the millennium; and Tanzania US $1.34 billion, with a whopping 500% increase over the same decade. Unfortunately, no such data are available for Angolan or Tanzanian diamonds. Relative to the rise in gold exports from Ghana and Tanzania recorded since 2011, however, diamond exports were far lower.

### Migration and settlement demography at successive stages of mineralized urbanization

There were clear demographic distinctions between our three mining site types. First were the artisanal rush sites, populated primarily by miners numbering a few hundred to several thousand, depending on the size of the mineral deposit and the elapse of time since the mineral discovery. The second type was mature artisanal sites, where years or even decades had elapsed since the first mineral rush. Residents pursued more diverse occupations, albeit mostly along the mining, trading and farming spectrum. Then there were the LSM sites, with populations of tens of thousands engaged in a multiplicity of economic activities marked by greater economic inequality. It should be noted that these settlement characteristics sometimes overlapped, as artisanal miners and their families were often present in and around the large-scale site, some eking out a marginalized existence.

Our objective is not to construct a typology of urban mining settlements by population size. Rather, it is to analyse the settlements' viability and fluidity according to their age on becoming urban settlements, as well as to examine the impact of the fluctuating availability of minerals as well as global mineral prices and mining investments in light of subsequent changes in population size and the on-site division of labour. Large-scale industrial as opposed to artisanal mining processes are radically different, with highly differentiated implications for educated families who have technically trained members, as opposed to families reliant on manual labour, lacking marketable skills and investment capital. Table 1 outlines the characteristics of the study sites to facilitate comparison.

Population agglomeration at mining sites depends on the elapse of time since the mineral discovery and excavation, the scale and depth of mining, and the richness of the mineral deposit. This section considers some common features at each stage of the mineralized urbanization trajectory before observing varied patterns along the continuum of difference.

– Artisanal rush sites

Nowadays the in-migration of labourers following mineral discovery can be exceptionally rapid with the expanding use of mobile phones throughout Africa (Afutu-Kotey and Gough, 2022). Rush sites, however, are not necessarily enduring, and many later revert to bush or contribute to village growth, the latter exemplified by diamond-mining Mwanangwa in Tanzania. Gold-rich Kenyasi in Ghana was experiencing a population upsurge at the time of our study, while Angola's sites with high diamond potential, Luó and Itengo, were on the verge of a population boom with the revival of the Luó LSM firm and the projected establishment of the large-scale ESCOM mine.

During a mineral boom, much depends on whether the influx of migrants dominates, as opposed to there being a critical mass of local miners already on site. In Tanzania, households in the rush/new discovery sites displayed a heavily male-biased sex ratio averaging 1.30, reflecting the dominance of migrants rather than native-born residents at the site. Table 2 provides a summary of key demographic characteristics of the surveyed households. The shading darkens in intensity with the rising value of measured variables.

Heads of household at the Tanzanian gold-mining sites were dominated by long-distance gold-seeking migrants who were unmarried and childless, most having arrived less than three years before. Many gold rush miners had already left by the time of our

**TABLE 1** Background to the case-study settlement sites

| Settlement type/ characteristic | Gold Ghana | Gold Tanzania | Diamonds Tanzania | Diamonds Angola |
|---|---|---|---|---|
| *Artisanal rush sites* | | | | |
| Name of site | KENYASI Brong-Ahafo region | IKUZI Geita region | MWANANGWA Mwanza region | LUÓ- ITENGO Lunda Sul province |
| Mineral discovery | 1920s | 1980s | 1940 | 1912 |
| Population* | 11,444 | 3,907 | 6,054 | 3,900 |
| Site origin/description | Traditional agricultural village near artisanal rush site | Rush site near traditional village | Rush site near pre-colonial trade centre | Luó artisanal mine sites near large-scale mine; Itengo traditional village near artisanal mining and planned large-scale mine |
| Mineral discovery | 2004 gold discovered | July 2010 rush | 1979 surge, 2009 rush | pipe discovered in 1965 |
| *Artisanal mature sites* | | | | |
| Name of site | PRESTEA Western region | NYARUGUSU Geita region | MAGANZO Shinyanga region | CACOLO Lunda Sul province |
| Population* | 16,827 | 24,802 | 11,877 | 32,000 |
| Site origin/description | Mining centre since 1920s; underground LSM halted in 1998; replaced by surface mining and ASM | Colonial village and early gold exploration | Originally a labour camp for miners at the Williamson mines in the 1940s | Mining settlement since 1910; first discoveries in the early 1960s; site of UNITA-controlled artisanal mining during civil war; diamond trade centre since 2012 |
| *Large-scale sites* | | | | |
| Name of site | OBUASI Ashanti region | GEITA Geita region | MWADUI Shinyanga region | SAURIMO/CATOCA Lunda Sul province |
| Population* | 143,644 | 100,852 | 9,390 | 83,000 |
| Settlement origin/ description | Founded late nineteenth century and principal gold-mining centre in Ghana; LSM and ASM on-going | Founded in 1898 during German colonial rule | Established in 1940 by geologist John Williamson | Founded in 1927; produces 80% of Angola's diamond wealth; pipe discovered in 1965 |
| Mineral discovery | Founded in the nineteenth century | 1930 mine established, closed 1966, reopened 2000 | 1940 mine established | First diamonds processed in 1997 |

NOTE * denotes populations are based on current estimates of the local government officials interviewed.
SOURCE: UPIMA household survey (2012)

survey, given the declining gold supply. In Ghana, however, the local/migrant origins of Kenyasi's heads of household were more finely balanced, with one-third coming from the site itself, roughly one-third from the surrounding area, and one-third from distant districts. Many of the indigenous population had lived elsewhere and then returned to their home area, attracted by the artisanal gold-mining opportunities. Contrary to what is expected in a rush site, the sex ratio was balanced (1.01). Men were typically more mobile, often temporarily seeking income-generating opportunities elsewhere, whereas women sought a stable place *in situ* to trade and work in the service economy while raising children and living in close proximity to extended family members who could assist with childcare. Twenty-two percent of Kenyasi's households had female heads and the average household size was four members. Both the Ghanaian gold and Tanzanian diamond sites can be characterized as residentially enduring households.

At the Tanzanian diamond site, Mwanangwa, one-third of the household heads were born on site, yet the overall sex ratio was strongly male-biased (1.25), reflecting an influx of miners digging for diamonds. The household size averaged 5.5 members, which included lodging miners as well as family members. The dependency ratio

**TABLE 2** Key demographic characteristics of the surveyed households by mineral/country/site (mean averages)

| Mineral | GOLD | | | | | | | | DIAMONDS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | Tanzania | | | | Ghana | | | | Tanzania | | | | Angola | | | |
| Site | Ikuzi | Nyaru-gusu | Geita | *ALL* | Kenyasi | Prestea | Obuasi | *ALL* | Mwan-angwa | Maganzo | Mwadui | *ALL* | Luo-Itengo | Cacolo | Saurimo | *ALL* |
| Surveyed HHs | 36 | 36 | 36 | *108* | 80 | 120 | 160 | *360* | 36 | 36 | 36 | *108* | 36+18 | 36 | 36 | *126* |
| **Head of Household's (HHH) locational characteristics** | | | | | | | | | | | | | | | | |
| Born on site (%) | 2.8 | 0 | 8.3 | ***3.7*** | 35.0 | 27.5 | 22.5 | ***26.9*** | 33.3 | 41.7 | 13.9 | *30* | 3.7 | 58.3 | 22.2 | ***28*** |
| Mean year of arrival | 2009 | 1988 | 1997 | ***1998*** | 1984 | 1986 | 1985 | ***1985*** | 1985 | 1983 | 1987 | *1985* | 1989 | 1987 | 1989 | ***1988*** |
| Years resident at site | 1.7 | 23.3 | 21.6 | ***15.5*** | 26.9 | 24.8 | 26.1 | **25.8** | 26.4 | 28.0 | 24.0 | *26.1* | 22.1 | 24.2 | 22.3 | ***22.9*** |
| **Age/Sex** | | | | | | | | | | | | | | | | |
| Mean age HHH | 40 | 52 | 47 | ***46*** | 43 | 41 | 43 | ***42*** | 46 | 46 | 45 | *46* | 47 | 47 | 42 | ***45*** |
| Female HHH (%) | 19 | 19 | 22 | ***20*** | 22 | 6 | 28 | ***19*** | 11 | 22 | 6 | *13* | 7 | 8 | 11 | ***9*** |
| Sex ratio (m/f) HHH | 1.30 | 1.04 | 1.24 | ***1.19*** | 1.01 | 1.16 | 0.97 | ***1.05*** | 1.25 | 1.08 | 0.91 | *1.08* | 0.96 | 1.03 | 1.06 | ***1.01*** |
| **Households' (HH) demographic characteristics** | | | | | | | | | | | | | | | | |
| Mean members/HH | 3.1 | 6.4 | 6.3 | ***5.3*** | 3.9 | 3.8 | 4.0 | ***3.9*** | 5.5 | 5.3 | 5.0 | *5.3* | 6.9 | 8.1 | 7.1 | ***7.4*** |
| Dependency ratio (%) | 10 | 36 | 40 | **29** | 40 | 32 | 44 | ***39*** | 28 | 34 | 46 | *36* | 31 | 39 | 62 | ***44*** |
| Three-generation family (%) | 3 | 11 | 36 | ***17*** | 28 | 0 | 11 | ***13*** | 11 | 8 | 6 | *8* | 30 | 19 | 6 | ***18*** |

NOTE: The shading darkens in intensity with the rising value of measured variables.
SOURCE: UPIMA household survey (2012)

was below average at 28%.[6] The Angolan diamond rush site Luó-Itengo was an extended area combining two adjacent settlements of in-migration with only 3.7% of the household heads born on site. Like Mwanangwa, it had a large household size (6.9 members) associated with a high incidence of three-generational families, yet family membership recorded a low dependency ratio of 31%, and a female-biased sex ratio of 0.96. The incongruity of Luó-Itengo's demographic survey data is linked to the reporting households' efforts to downplay the existence of illegal male artisanal diamond miners, in contravention of the Angolan government's strict ban on artisanal mining (Udelsmann Rodrigues and Bryceson, 2018).

Returning to Abu-Lughod's comparative methodology, there are marked similarities across countries with respect to levels of population agglomeration, but the settlements' conditional contexts serve to generate variable centripetal and centrifugal movements, differentiating the demographic patterns of age and sex between sites. Tanzania's and Ghana's recent localized gold surges spurred the classic population influx of rush sites, with a more subdued response in the case of Tanzania's diamond rush site. Distinctly, Angola's disruptive history of civil war was followed by the slow rebirth of LSM, while the existing ASM activity was ongoing, but facing a highly uncertain future.

– Mature artisanal sites

In the face of a declining local mineral supply, mature sites are often made up of households whose members have been left behind, usually due to the existence of school-age children and working wives who root the family to the site. To make ends meet, the heads of household, spouses and adult children tend to diversify into trade, services or agriculture, rarely with the economic success they would have expected from a mineral-rich site.

In Nyarugusu, Tanzania's gold-producing site, most of the heads of household had migrated there during the settlement's early gold rushes in the 1980s and had an average residence of 23 years. They constituted a stable population of older married household heads living in households with a relatively balanced sex ratio (1.04), a large household size (6.4), and a high dependency ratio (36%). Tanzania's mature artisanal diamond site, Maganzo, had a similar dependency ratio (34%) and sex ratio (1.08), with residential stability averaging 28 years. This settlement had evolved towards a workable household configuration, providing residential stability while continuing to pursue mining in a mixed occupational manner.

Prestea, Ghana's mature artisanal mining settlement, provides a striking contrast to its counterpart settlement in Tanzania. The household sex ratio was male-biased (1.16). Twenty-eight percent of the household heads were born on site, with the non-indigenous weighted towards distant places (44%). Nonetheless, household heads averaged 25 years of residence but only two-thirds reported living with their spouse on-site. Cacolo, Angola's mature artisanal settlement, had the highest level of indigenous household heads (58%), and the biggest household size in the entire three-country sample (8.1 members). The household sex ratio was relatively balanced (1.03), with a moderate incidence of three-generational households (19%).

Overall, the mature sites were relatively stable demographically, despite being subject to mineral depletion over time and the consequent centrifugal pressure to search for alternative livelihoods. Nonetheless, the gold sites evidenced differentiated forms of mineral depletion: ASM in Tanzania had led to the Tanzanian households' mixed occupational portfolios, whereas diversification in Ghana, resulting from the decline in industrial mining, had propelled households towards an *in situ* ASM digging alternative. In the diamond sites of Tanzania and Angola, residential stability and

6 The dependency ratio is defined as people under 15 and over 64 years of age divided by the total population aged 15 to 64.

the large size of households was especially pronounced. Both sites were evolving into diamond trading centres, particularly in Angola, where Cacolo's history of LSM supported a settlement three times bigger than Maganzo in Tanzania, where ASM had historically prevailed.

– Large-scale mining sites

The demography of large-scale mining sites during a mineral boom is of large, occupationally diverse migrant populations. All three of the LSM cities in our survey recorded the largest household sizes and the highest household dependency ratios relative to the other sites.[7] High urban household dependency ratios in Sub-Saharan Africa spring from the relative affluence of middle-class households in urban areas, which can then afford to house opportunity-seeking rural relations (Mercer, 2014).[8]

In Tanzania, the commercial multiplier effects of the Geita Gold Mine (GGM) dominated the economy of Geita city. The heads of household recorded large families (mean 6.3 members) with a high dependency ratio (40%). The sex ratio was male-biased (1.24) because of the hope of formal or informal employment connected with GGM. Yet GGM offered very limited formal employment opportunities, with most jobs requiring advanced education. Resident artisanal miners worked close to the large-scale mine.

Mwadui, a self-contained diamond mining company town, comprised fewer than 10,000 people. The mine and its housing were encircled by a high security fence to prevent outbound diamond smuggling or entry by illegal artisanal miners. The mine employees and their relatives who were authorized to live there obtained most of their goods and services, including a medical dispensary and schools, within the fenced area. The incidence of female-headed households was negligible. The LSM employment was male-dominated and to be eligible to reside there, adult women generally had to be either married to a male employee or employed as a teacher or nurse, for example, within the mining company town. Most of the male employees were educated migrants who had gained their jobs thanks to their higher education and training.

In Ghana, female-headed households in Obuasi were relatively prominent (28%), in conjunction with a female-biased sex ratio (0.97). Heads of households' average age was 43 years, but they shouldered high dependency ratios (44%). The number of migrant household heads (34%) from distant areas exceeded that of native-born heads of household (28%). In Angola, the number of native-born Saurimo household heads was lower (22%). Saurimo's household size (7.1) was associated with an exceptionally high dependency ratio composed of many children under 15 years of age, which could be a result of them being orphaned during the civil war. Similarly, a low incidence of three-generational households may be related to high adult mortality rates during the war.

Abu-Lughod's (1975) focus on the way that social structures inform urbanizing spatial patterns is abundantly evident at this stage of mineralized urbanization. While household composition has a major impact on coping strategies and economic viability in rush sites and mature ASM sites, in mining towns, household composition and social class reflect a strong centripetal movement towards the town. People flock to the town to get jobs or start businesses in the hope of increasing their income and purchasing power. Households which have achieved higher, stable earnings are distinguishable from others, revealing a process of local class differentiation. Another wave of in-migration follows,

7 Dependency ratios in the mining cities and towns were: Geita, Tanzania, 40%; Mwadui, Tanzania, 46%; Obuasi, Ghana, 44%; and Saurimo, Angola, 62%.

8 Incoming extended rural-based family members seek residence in their middle-class relatives' homes where they can access superior educational and medical services, and rural teenage girls are recruited to help with the urban household's housework and childcare (Bryceson, 2019). Any class differences in the smaller urbanizing settlements are barely detectable. Saving households generally avoid displays of wealth for fear of attracting jealousy, theft or pressure from relatives to share their wealth.

as young up-country migrant relations join their higher-earning relations in the town to gain access to better schools and economic opportunities. Their movement leads to further urban population concentration, higher dependency ratios and larger family sizes in households relative to the ASM settlements.

### Occupational dynamics

Broadly speaking, over the course of a site's mining trajectory the exploitation of minerals typically begins at, or close to, the surface with the discovery of placer deposits[9] and panning in rivers. The mining then moves steadily deeper into the earth with tunnels built by artisanal miners using hand tools or by large-scale mining with mechanical means capable of reaching much greater depths. As deposits diminish in concentration at sites, it may still be profitable for LSM to literally scour the earth with opencast mining, as has occurred in Prestea, Ghana (Yankson and Gough, 2019). Hydraulic diamond mining and the large-scale redirection of river courses using earth-moving equipment is found in Angola (Caetano and Reis, 2013: 23). Such forms of large-scale mechanized digging further preclude opportunities for unskilled labour.

Meanwhile, depending on the level of purchasing power emanating from the mining population, localities attract large numbers of migrants aiming to earn a living by provisioning goods and services. The unfolding process of mineral extraction gives rise to population influx alongside occupational specialization and diversification that are the fundamental components of urbanization. It is revealing to interrogate how the occupational dynamics change across mining sites, representing different temporal stages and spatial locations in the mining zone. Between 2002 and the peak of the mineral boom in 2012, significant changes in households' occupational patterns were evident in most of the surveyed settlements. Table 3 compares the primary and secondary income sources by key occupational sector (mining, agriculture, trade, services or none) between the different sites. Light to dark shading indicates rising percentages.

Mining as an occupation expanded in all of the Ghanaian gold sites and the Tanzanian artisanal rush and large-scale mining sites throughout the decade, with the exception of the mature artisanal gold and diamond sites, where it declined by 30%. These were in effect mineral-depleted sites. As households' involvement in mining expanded, agricultural activity shrank almost everywhere, reflecting mining's more profitable returns relative to farming between 2002 and 2012. The exception was Geita, where both activities developed in tandem. The city's exceptionally rapid demographic growth was accompanied by inflated food prices. Some households therefore had to engage in agricultural production to ensure there was adequate food for consumption.

Obuasi, Ghana's main gold centre, and the diamond capital of Saurimo were notable exceptions. Households' agricultural involvement was practically absent in both 2002 and 2012, arising from less space for farming and the more advanced levels of Ghanaian urbanization affording more diversified income-generating opportunities. In Angola, the destructive impact of the civil war on the country's agricultural sector had depressed agriculture in 2002, which then doubled in size 10 years later. By contrast, Tanzania's lower per capita GDP and lack of a public welfare system meant that people had to engage in subsistence agricultural production in many, if not most, urban areas (Flynn, 2001).

Curiously, Angola's covert diamond rush site, Luó-Itengo, reported a bonanza increase in agriculture of 225%, while other sectors decreased. As previously observed, households in Luó-Itengo had tell-tale signs of similarity with the Tanzanian diamond rush site, with a low dependency ratio and an improbable female-biased sex ratio. The anomalous 'agriculture' boom similarly masked the existence of the households' illegal *garimpo* artisanal mining activity. An agricultural boom of this magnitude would be highly unlikely in a country where war and landmines had posed an obstacle to

9 Placer deposits are mineral deposits that have been displaced from their point of origin to stream beds through water erosion.

**TABLE 3** Comparison of the surveyed households' primary and secondary income sources by sector in 2012 and 2002 (%)

| | GOLD | | | | | | | | DIAMONDS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | Tanzania | | | | Ghana | | | | Tanzania | | | | Angola | | | | |
| Site | Ikuzi | Nyaru-gusu | Geita | *ALL* | Kenyasi | Prestea | Obuasi | *ALL* | Mwan-angwa | Maganzo | Mwadui | *ALL* | Luo-Itengo | Cacolo | Saurimo | *ALL* | |
| Survey HHs | 36 | 36 | 36 | *108* | 160 | 80 | 120 | *360* | 36 | 36 | 36 | *108* | 36+18 | 36 | 36 | *126* | |
| **3.1 Main households' income source by sector (% of total households)** | | | | | | | | | | | | | | | | | |
| ***Main Household Employment 2012*** | | | | | | | | | | | | | | | | | Scale |
| Mining | 69.4 | 41.7 | 11.1 | ***40.7*** | 19.4 | 30.6 | 50.0 | ***33.3*** | 38.9 | 27.8 | 69.4 | ***45.4*** | 13 | 2.8 | 2.8 | ***6.2*** | 60+ |
| Farming | 5.6 | 41.7 | 25 | ***24.1*** | 5.6 | 30.6 | 5.6 | ***13.9*** | 38.9 | 30.6 | 2.8 | ***24.1*** | 72.2 | 38.9 | 0 | ***37.0*** | 40-59 |
| Trade | 19.4 | 5.6 | 13.9 | ***13.0*** | 25.0 | 8.3 | 19.4 | ***17.6*** | 22.2 | 30.6 | 5.6 | ***19.5*** | 5.6 | 8.3 | 19.4 | ***11.1*** | 30-39 |
| Services | 5.6 | 11.1 | 47.2 | ***21.3*** | 36.1 | 27.8 | 13.9 | ***25.9*** | 0 | 11.1 | 19.4 | ***10.2*** | 9.3 | 47.2 | 72.2 | ***42.9*** | 20-29 |
| Not working | 0 | 0 | 2.8 | ***0.9*** | 13.9 | 2.8 | 11.1 | ***9.3*** | 0 | 0 | 2.8 | ***0.9*** | 0 | 2.8 | 5.6 | ***2.8*** | 10-19 |
| ***Main Household Employment 2002*** | | | | | | | | | | | | | | | | | 1-9 |
| Mining | 19.4 | 61.1 | 5.6 | ***28.7*** | 5.6 | 5.6 | 36.1 | ***15.8*** | 16.7 | 38.9 | 36.1 | ***30.6*** | 16.7 | 22.2 | 11.1 | ***16.7*** | 0 |
| Farming | 38.9 | 22.2 | 22.2 | ***27.8*** | 5.6 | 41.7 | 8.3 | ***18.5*** | 66.7 | 27.8 | 11.1 | ***35.2*** | 22.2 | 25.0 | 0 | ***15.7*** | |
| Trade | 19.4 | 2.8 | 16.7 | ***13.0*** | 25.0 | 8.3 | 13.9 | ***15.7*** | 11.1 | 8.3 | 11.1 | ***10.2*** | 9.3 | 0 | 16.7 | ***8.7*** | |
| Services | 13.9 | 8.3 | 36.1 | ***19.4*** | 27.8 | 13.9 | 13.9 | ***18.5*** | 2.8 | 11.1 | 11.1 | ***8.3*** | 22.2 | 19.4 | 38.9 | ***26.8*** | |
| Not working | 8.3 | 5.6 | 19.4 | ***11.1*** | 36.0 | 30.6 | 27.8 | ***31.5*** | 2.8 | 13.9 | 30.6 | ***15.8*** | 29.6 | 33.3 | 33.3 | ***32.1*** | |
| ***Secondary Household Employment 2012*** | | | | | | | | | | | | | | | | | |
| Mining | 16.7 | 33.3 | 11.1 | ***20.4*** | 0 | 8.3 | 2.8 | ***3.7*** | 33.3 | 19.4 | 5.6 | ***19.4*** | 0 | 2.8 | 2.8 | ***1.9*** | |
| Farming | 36.1 | 41.7 | 27.8 | ***35.2*** | 5.6 | 19.4 | 5.6 | ***10.2*** | 30.6 | 41.7 | 25.0 | ***32.4*** | 16.7 | 25.0 | 0 | ***13.9*** | |
| Trade | 25.0 | 16.7 | 19.4 | ***20.4*** | 33.3 | 8.3 | 41.7 | ***27.8*** | 5.6 | 16.7 | 8.3 | ***10.2*** | 3.7 | 2.8 | 19.4 | ***8.6*** | |
| Services | 5.6 | 2.8 | 11.1 | ***6.5*** | 16.7 | 11.1 | 16.7 | ***14.8*** | 8.3 | 8.3 | 8.3 | ***8.3*** | 3.7 | 8.3 | 22.2 | ***11.4*** | |
| None | 16.7 | 5.6 | 30.6 | ***17.6*** | 44.4 | 52.8 | 33.3 | ***43.5*** | 22.2 | 13.9 | 52.8 | ***29.6*** | 76 | 61.1 | 55.6 | ***64.2*** | |
| ***Secondary Household Employment 2002*** | | | | | | | | | | | | | | | | | |
| Mining | 2.8 | 5.6 | 2.8 | ***3.7*** | 0 | 0 | 0 | ***0*** | 0 | 8.3 | 5.6 | ***4.6*** | 0 | 2.8 | 0 | ***0.9*** | |
| Farming | 19.4 | 41.7 | 22.2 | ***27.8*** | 2.8 | 11.1 | 5.6 | ***6.5*** | 2.8 | 33.3 | 13.9 | ***16.7*** | 7.4 | 11.1 | 0 | ***6.2*** | |
| Trade | 16.7 | 11.1 | 2.8 | ***10.2*** | 25.0 | 11.1 | 27.7 | ***21.3*** | 2.8 | 5.6 | 2.8 | ***3.7*** | 0 | 0 | 5.6 | ***1.9*** | |
| Services | 0 | 0 | 8.3 | ***2.8*** | 2.8 | 2.8 | 8.3 | ***4.6*** | 0 | 0 | 2.8 | ***0.9*** | 5.6 | 8.3 | 5.6 | ***6.5*** | |
| None | 61.1 | 41.6 | 63.9 | ***55.5*** | 69.4 | 75.0 | 58.4 | ***67.6*** | 94.4 | 52.8 | 75.0 | ***74.1*** | 87.0 | 77.8 | 88.9 | ***84.6*** | |
| ***Other 2012 income flows (%)*** | | | | | | | | | | | | | | | | | |
| Remittances | 0 | 14 | 25 | ***13*** | 19 | 22 | 14 | ***18*** | 0 | 6 | 0 | ***2*** | 6 | 3 | 0 | ***3*** | |

**TABLE 3** Continued

| 3.2 Magnitude of households' percentage increase/decrease of income source between 2002 and 2012 by sector | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Primary source* | | | | | | | | | | | | | | | | | Scale |
| Mining | 258 | -32 | 98 | ***42*** | 246 | 446 | 39 | ***111*** | 133 | -29 | 92 | 48 | -22 | -87 | -75 | -63 | 200+ |
| Farming | -86 | 88 | 13 | ***-13*** | 0 | -27 | -33 | ***-25*** | -42 | 10 | -75 | -32 | 225 | 56 | 0 | 135 | 100-199 |
| Trade | 0 | 100 | -17 | ***0*** | 0 | 0 | 40 | ***12*** | 100 | 269 | -50 | 91 | -40 | n.c. | 16 | 28 | 50-99 |
| Services | -60 | 34 | 31 | ***10*** | -30 | -100 | 0 | ***40*** | -100 | 0 | 75 | 22 | -58 | 143 | 86 | 60 | 1-49 |
| *Secondary source* | | | | | | | | | | | | | | | | | Scale |
| Mining | 496 | 495 | 296 | ***446*** | 0 | n.c. | n.c. | ***n.c.*** | n.c. | 134 | 0 | ***319*** | 0 | 0 | n.c. | ***0*** | -1-49 |
| Farming | 86 | 0 | 25 | ***27*** | 100 | 75 | 0 | ***57*** | 993 | 25 | 80 | ***95*** | 126 | 125 | 0 | ***125*** | -50-99 |
| Trade | 50 | 50 | 593 | ***100*** | -33 | -25 | 51 | ***31*** | 100 | 198 | 196 | ***173*** | n.c. | n.c. | 246 | ***363*** | -100 |
| Services | n.c. | n.c. | 34 | ***135*** | 496 | 296 | 101 | ***220*** | n.c. | n.c. | 196 | ***789*** | -34 | 0 | 296 | ***75*** | |

NOTES: Formula used: (2012/2002-1)*100 = % increase or decrease; n.c. denotes not calculable due to the 2002 incidence of sectoral income source being zero; the line labelled '% remittances' has no scale, but is shaded from light to dark according to % escalation.
SOURCE: UPIMA household survey (2012)

**TABLE 4** Housing standards, infrastructure and possessions of the surveyed households (mean averages)

| | GOLD | | | | | | | | DIAMONDS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | TANZANIA | | | | GHANA | | | | TANZANIA | | | | ANGOLA | | | | |
| Site | Ikuzi | Nyaru-gusu | Geita | *ALL* | Kenyasi | Prestea | Obuasi | *ALL* | Mwan-angwa | Maganzo | Mwadui | *ALL* | Luó-Itengo | Cacolo | Saurimo | *ALL* | |
| Survey HHs | 36 | 36 | 36 | *108* | 80 | 120 | 160 | *360* | 36 | 36 | 36 | *108* | 54 | 36 | 36 | *126* | |
| ***Roofing (%)*** | | | | | | | | | | | | | | | | | Scale |
| Tarpaulin | 91.7 | 0 | 0 | ***31*** | 0 | 0 | 0 | ***0*** | 8.3 | 0 | 0 | ***3*** | 0 | 0 | 0 | ***0*** | 80+ |
| Thatched | 0 | 11.1 | 0 | ***4*** | 0 | 0 | 0 | ***0*** | 41.7 | 11.1 | 0 | ***18*** | 64.8 | 0 | 0 | ***22*** | 60–79 |
| Makeshift corrugated iron | 2.8 | 13.9 | 2.8 | ***7*** | 0 | 0.8 | 0.6 | ***0.6*** | 19.4 | 0 | 0 | ***6*** | 16.7 | 25 | 2.8 | ***15*** | 40–59 |
| Fixed corrugated iron | 2.8 | 66.7 | 97.2 | ***56*** | 100 | 89.2 | 99.4 | ***96.1*** | 30.6 | 83.3 | 5.6 | ***40*** | 18.5 | 75 | 88.9 | ***61*** | 20–39 |
| Combination or other | 2.8 | 8.3 | 0 | ***4*** | 0 | 0.8 | 0 | ***0.3*** | 0 | 5.6 | 94.4 | ***33*** | 0 | 0 | 8.4 | ***3*** | 1–19 |
| ***Walls (%)*** | | | | | | | | | | | | | | | | | 0 |
| Makeshift | 69.4 | 0 | 0 | ***23*** | 5.1 | 1.7 | 0.6 | ***2*** | 8.3 | 0 | 0 | ***3*** | 3.7 | 0 | 0 | ***1*** | |
| Mud | 25 | 69.4 | 2.8 | ***32*** | 12.8 | 32.5 | 13.8 | ***19.8*** | 83.3 | 55.6 | 0 | ***46*** | 92.6 | 75 | 30.6 | ***66*** | |
| Combination or other | 5.6 | 0 | 0 | ***2*** | 0 | 0 | 0 | ***0*** | 0 | 2.8 | 0 | ***1*** | 1.9 | 2.8 | 2.8 | ***3*** | |
| Brick or cement | 0 | 30.6 | 97.2 | ***43*** | 82.1 | 65.8 | 85.6 | ***78.2*** | 8.3 | 41.7 | 100 | ***50*** | 1.9 | 22.2 | 66.7 | ***30*** | Scale |
| ***Number of bedrooms*** | | | | | | | | | | | | | | | | | 3+ |
| Lodger bedrooms | 0.1 | 1.1 | 0.9 | ***0.7*** | 0.6 | 0.6 | 0.6 | ***0.6*** | 0.3 | 1.7 | 0.1 | ***0.7*** | 0.1 | 0.2 | 0.3 | ***0.2*** | 1–2.9 |
| Family bedrooms | 1.9 | 4.6 | 3.4 | ***3.3*** | 2.0 | 1.7 | 1.7 | ***1.8*** | 3.5 | 4.3 | 3.1 | ***3.7*** | 1.9 | 2.6 | 2.8 | ***2.3*** | 0.1–0.9 |
| ***Main form of water supply (%)*** | | | | | | | | | | | | | | | | | Scale |
| Own-fetched | 94 | 3 | 31 | ***43*** | 6 | 1 | 1 | ***3*** | 55 | 25 | 14 | 31 | 94 | 58 | 0 | ***51*** | 80+ |
| Purchased from seller | 0 | 39 | 31 | ***23*** | 39 | 56 | 24 | ***40*** | 44 | 67 | 3 | *38* | 4 | 39 | 66 | ***36*** | 60–79 |
| Neighbour's well | 0 | 41 | 11 | ***17*** | 7 | 4 | 5 | ***5*** | 0 | 0 | 0 | *0* | 0 | 0 | 0 | ***0*** | 40–59 |
| Own piped supply | 0 | 0 | 8 | ***3*** | 17 | 12 | 36 | ***21*** | 0 | 0 | 81 | ***27*** | 0 | 0 | 22 | ***7*** | 20–39 |
| Own well | 0 | 11 | 17 | ***9*** | 7 | 3 | 7 | ***6*** | 0 | 3 | 0 | ***1*** | 0 | 0 | 8 | ***3*** | 1–19 |
| Borehole | 0 | 0 | 0 | ***0*** | 7 | 23 | 26 | ***18*** | 0 | 0 | 0 | ***0*** | 0 | 0 | 0 | ***0*** | 0 |
| Public pipe supply | 0 | 0 | 0 | ***0*** | 10 | 0 | 1 | ***4*** | 0 | 0 | 0 | ***0*** | 0 | 0 | 0 | ***0*** | |
| Other | 6 | 6 | 2 | ***5*** | 7 | 1 | 0 | ***3*** | 1 | 5 | 2 | ***3*** | 2 | 3 | 4 | ***3*** | |

**TABLE 4** Continued

| *Main form of energy supply (%)* | | | | | | | | | | | | | | | | | Scale |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Firewood | 8 | 25 | 17 | ***17*** | 16 | 5 | 3 | ***8*** | 56 | 25 | 5 | ***29*** | 76 | 11 | 0 | ***29*** | 60+ |
| Charcoal | 53 | 39 | 58 | ***50*** | 45 | 72 | 58 | ***58*** | 11 | 33 | 25 | ***23*** | 24 | 89 | 69 | ***61*** | 50–59 |
| Firewood & charcoal | 19 | 36 | 22 | ***26*** | 5 | 2 | 3 | ***3*** | 33 | 42 | 0 | ***25*** | 0 | 0 | 3 | ***1*** | 30–49 |
| Electricity | 0 | 0 | 0 | ***0*** | 0 | 3 | 5 | ***3*** | 0 | 0 | 6 | ***2*** | 0 | 0 | 6 | ***2*** | 10–29 |
| Charcoal & electricity | 0 | 0 | 3 | ***1*** | 0 | 0 | 0 | ***0*** | 0 | 0 | 50 | ***17*** | 0 | 0 | 0 | ***0*** | 1-9 |
| Firewood, charcoal & electricity | 0 | 0 | 0 | ***0*** | 0 | 0 | 0 | ***0*** | 0 | 0 | 14 | ***5*** | 0 | 0 | 0 | ***0*** | 0 |
| Biogas & gas | 0 | 0 | 0 | ***0*** | 22 | 16 | 25 | ***21*** | 0 | 0 | 0 | ***0*** | 0 | 0 | 22 | ***7*** | |
| Other | 20 | 0 | 0 | ***7*** | 12 | 2 | 6 | ***7*** | 0 | 0 | 0 | ***0*** | 0 | 0 | 0 | ***31*** | |
| ***Household's consumer goods ownership (%)*** | | | | | | | | | | | | | | | | | **Scale** |
| Bicycles | 17 | 72 | 50 | ***46*** | 38 | 11 | 19 | ***22*** | 64 | 44 | 81 | ***63*** | 19 | 31 | 6 | ***18*** | 80+ |
| Motorbikes | 6 | 6 | 6 | ***6*** | 19 | 2.5 | 5 | ***9*** | 14 | 11 | 19 | ***15*** | 6 | 33 | 53 | ***31*** | 60–79 |
| 4-wheel vehicle | 0 | 6 | 14 | ***7*** | 16 | 5 | 14 | ***12*** | 0 | 8 | 22 | ***10*** | 2 | 6 | 19 | ***9*** | 40–59 |
| Mobile phone | 81 | 81 | 92 | ***84*** | 95 | 91 | 93 | ***93*** | 61 | 78 | 97 | ***79*** | 22 | 67 | 83 | ***57*** | 20–39 |
| Landline | 3 | 0 | 3 | ***2*** | 1 | 1 | 0 | ***1*** | 3 | 8 | 8 | ***6*** | 0 | 0 | 3 | ***1*** | 10–19 |
| Computer | 0 | 3 | 3 | ***2*** | 23 | 11 | 34 | ***23*** | 0 | 3 | 14 | ***6*** | 0 | 0 | 6 | ***2*** | 1–9 |
| Internet access | 0 | 0 | 0 | ***0*** | 9 | 2 | 12 | ***7*** | 0 | 0 | 0 | ***0*** | 0 | 0 | 83 | ***0*** | 0 |
| Radio | 39 | 22 | 56 | ***39*** | 76 | 88 | 88 | ***84*** | 78 | 75 | 75 | ***76*** | 22 | 61 | 83 | ***56*** | |
| TV | 17 | 0 | 1 | ***6*** | 63 | 87 | 86 | ***78*** | 3 | 33 | 83 | ***40*** | 11 | 47 | 83 | ***47*** | |
| DVD/VCD | | | | | 21 | 36 | 38 | ***32*** | | | | | | | | | |

SOURCE: UPIMA household survey (2012)

agriculture for over a generation and a half. Most young people had little familiarity with smallholder agriculture, and older people were unlikely to rush back to farming after years away from the sector. Thus, local people's lack of formal education left them with no option other than diamond-digging (Pearce, 2001; 2004; Marques, 2011; Caetano and Reis, 2013; Udelsmann Rodrigues, 2017b).

Between 2002 and 2012 in Ghana and Tanzania the increase in gold mining was accompanied by an unchanged significance of trade as an income source (see Table 3). At gold rush sites residents focused on lucrative mining, whereas the pattern in diamond mining was different. In Tanzania's diamond rush sites, mining and trade were paired as the households' main income sources. In Angola, a drastic decline in the reported significance of LSM in Cacolo (-87%) and Saurimo (-75%) reflected the transitional state of a return to LSM after the civil war. The smaller 22% decline in Luó-Itengo should be read in conjunction with the meteoric rise in households' agricultural income due to the return of displaced residents and local people's tactical strategies for hiding their illegal artisanal mining activities.

Between 2002 and 2012, both mining and service activities expanded in the LSM sites in Ghana and Tanzania, while mining specialization prevailed in the gold rush sites. Tanzanian bachelor miners increasingly concentrated on mining, which yielded the highest profit. Similarly, at Angola's artisanal rush site, the counterfactual leap in agriculture of 225%, alongside a 58% drop in service activities, suggested a growing engagement in mining. Meanwhile, large increases in service activities alongside declines in diamond mining in Angola's mature ASM and LSM sites reflected preparations for a planned relaunch of LSM.

Finally, the mature mineral sites in all three countries indicated an overall decline in mining, given the diminishing mineral concentrations and economic diversification into services and trade. Agriculture served as a subsistence fallback in Tanzania and to a lesser extent in Angola and Ghana. As for households' secondary employment sources during the gold boom of 2012, in ASM rush sites secondary household income-generation was uncommon, as residents were too focused on mining. Farming as a secondary income source was prevalent in mature ASM sites in Tanzania and to a lesser extent in Angola, while trade was most salient in Ghana. At all four LSM sites, the lack of any secondary household income-generation was the dominant pattern, hinting at a tendency towards specialization.

### Material rewards

The nature of residents' living accommodation differed markedly between the various types of mining settlement in terms of its availability, quality and attractiveness for investment. The early rush stages involved ad hoc and generally poor quality accommodation, while the mature sites presented larger self-built family housing made of local materials. The LSM sites had family housing generally made of more durable materials, but also poorer quality housing, reflecting the economic stratification of the population in LSM towns and cities.

#### – Housing

Artisanal rush sites in remote areas lacked any existing housing stock. Young unmarried male migrants arrived and by default were catapulted into poor, make-shift housing, some sleeping under tarpaulins, that constituted virtually cost-free temporary accommodation, as in Tanzania's gold rush site (for Ghana, see Kala, 2016). Where there was some existing accommodation, rooms in private family houses, some of which were purpose-built, were rented to miners, notably in the two diamond rush sites (Ikuzi and Luó-Itengo) and Ghana's gold rush site (Kenyasi) (see Table 4).

Across all three countries, the mature artisanal and LSM settlements had houses built mostly of permanent materials. Weather-proofed corrugated iron roofing

was most prevalent. At the opposite end of the roofing spectrum, tiled roofing graced Mwadui's securitized and gated residential compound. Adobe mud walls were common in Tanzania and Angola, but far less so in Ghana. Brick or cement walls prevailed in all three countries' highly urbanized LSM settlements. Own-fetched water was the norm in Tanzania's and Angola's rush and mature ASM sites, whereas piped water supplies were common in Ghana. Meanwhile, charcoal was the most common source of energy for cooking except in Mwadui's LSM compound, where staff had access to electricity.

– Property acquisition

The pattern of household ownership of consumer goods evidenced exceptionally high ownership of mobile phones, most prevalent at the urbanized LSM sites in all three countries and least prevalent in Angola's rush site. Ghana's surveyed households stood out for their very high TV ownership. Overall motor vehicle ownership was low, but it reached 12% in Ghana. In Tanzania, bicycle ownership (50% of households) superseded other modes of transport. Angolan households were endowed with the highest average motorbike ownership, ranging widely from 6% in the rush site to 53% at the LSM site.

While Ghanaians seemed more affluent in terms of material goods ownership, a different picture emerges when comparing house and land ownership between countries (see Table 5). At the time of the survey, only 20% of Ghanaian households had secured ownership of their on-site housing, due to the widespread incidence of family compound housing,[10] compared with Angolan households (62%). Tanzanian house ownership lay between the two extremes (47%).

Multiple house ownership was a notable feature of Tanzanian heads of household in particular, especially gold rush miners. The gold rush site recorded on-site house ownership of only 3% of the surveyed household heads, yet the mining heads of household scored an average of 2.4 houses owned per household because 67% of them owned houses at second sites, followed by 22% at third sites, 6% at fourth sites, and 3% at fifth sites. Average gold-mining house ownership across all the sites was relatively high at 1.7 houses per household. This illustrates how the successful Tanzanian miners invested in additional houses, typically in their home areas or in district/regional towns away from the discomfort and stress of the mining site.

Tanzania's diamond sites were markedly different, with an average house ownership of just 0.7, dragged down by the fact that house ownership was not an option for households on the corporately-owned LSM site at Mwadui. Angola was similarly placed with an average of 1.1 houses, ranging from 1.2 of a self-built nature at the ASM rush site to 0.9 at Saurimo, the LSM location. Ghana was extremely low at 0.4 houses on average, due to people living in houses that were owned ancestrally by families rather than individually by households. Furthermore, it was difficult to get a foothold in the more urbanized housing market in Ghana given the existing population density and large plot sizes, especially for migrants. In Prestea and Obuasi, miners who had previously lived in mining-company housing had to move to private rental accommodation when their LSM employment ended (Gough *et al*., 2019).

Rented rooms were most common in the gold-producing settlements of Ghana (46%) and Tanzania's diamond mining settlements (47%). In Angola, rented housing was particularly rare (2.8%).

– Welfare attainment: education, investment and food security

What struck us as the most salient factor across all the surveyed settlements was the quest for material economic advancement. Residents in the mining settlements believed that they had access to more promising life opportunities with a greater chance

10 In Ghanaian family compound houses, the interviewed head of household was not necessarily the house owner (who may have already died). Kinship ties pre-ordain that family members live communally and rent-free.

**TABLE 5** Surveyed households' housing and land assets

| | GOLD | | | | | | | | DIAMONDS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | TANZANIA | | | | GHANA | | | | TANZANIA | | | | ANGOLA | | | | |
| Site | Ikuzi | Nyaru-gusu | Geita | *ALL* | Kenyasi | Prestea | Obuasi | *ALL* | Mwan-angwa | Maganzo | Mwadui | *ALL* | Luó-Itengo | Cacolo | Saurimo | *ALL* | |
| Survey HHs | 36 | 36 | 36 | *108* | 80 | 120 | 160 | *360* | 36 | 36 | 36 | *108* | 36+18 | 36 | 36 | *126* | |
| ***Head of household's housing tenure (%)*** | | | | | | | | | | | | | | | | | Scale |
| *First residence* | | | | | | | | | | | | | | | | | 50+ |
| Owner occupier | 0.0 | 36.1 | 11.1 | ***15.7*** | 12.3 | 0.8 | 4.7 | ***5.9*** | 11.1 | 13.9 | 0 | ***8.3*** | 83.3 | 50.0 | 11.1 | ***48.1*** | 40–49 |
| Owned by family/friend | 19.4 | 33.3 | 27.8 | ***26.8*** | 49.3 | 35.2 | 48.2 | ***44.2*** | 61.1 | 44.4 | 0 | ***35.2*** | 9.3 | 11.1 | 27.8 | ***16.1*** | 30–39 |
| Rented | 5.6 | 30.6 | 58.3 | ***31.5*** | 33.3 | 62.3 | 44.4 | ***46.7*** | 27.8 | 41.7 | 100 | ***56.5*** | 1.6 | 5.6 | 30.6 | ***12.6*** | 20–29 |
| Other | 75.0 | 0 | 2.8 | ***25.9*** | 5.0 | 1.6 | 2.7 | ***3.2*** | 0 | 0 | 0 | ***0.0*** | 5.8 | 33.3 | 30.5 | ***23.2*** | 10–19 |
| *Current* | | | | | | | | | | | | | | | | | 1–9 |
| Owner occupier | 5.5 | 86.1 | 55.6 | ***49.1*** | 25.9 | 20.6 | 14.8 | ***20.4*** | 61.1 | 72.2 | 0 | ***44.4*** | 77.8 | 41.7 | 66.7 | ***62.1*** | <= 0 |
| Rented | 5.6 | 8.3 | 33.3 | ***15.7*** | 38.3 | 57.4 | 43.2 | ***46.3*** | 25.0 | 16.7 | 100.0 | ***47.2*** | 0 | 2.8 | 5.6 | ***2.8*** | |
| Owned by family/friend | 5.5 | 5.6 | 11.1 | ***7.4*** | 33.3 | 19.8 | 35.2 | ***29.4*** | 13.9 | 11.1 | 0 | ***8.3*** | 0 | 2.8 | 11.1 | ***4.6*** | |
| Other | 83.4 | 0 | 0 | ***27.8*** | 2.5 | 2. 2 | 6.8 | ***3.8*** | 0 | 0 | 0 | ***0.0*** | 22.2 | 52.8 | 16.7 | ***30.6*** | |
| ***Head of household's multiple house ownership (%)*** | | | | | | | | | | | | | | | | | Scale |
| On-site house* | 2.8 | 86.1 | 55.6 | ***49.1*** | 25.9 | 20.6 | 14.8 | ***20.4*** | 61.1 | 72.2 | 0 | ***44.4*** | 77.8 | 41.7 | 66.7 | ***62.1*** | 80+ |
| 2nd site | 66.7 | 13.9 | 27.8 | ***36.1*** | 7.5 | 6.7 | 5.0 | ***6.4*** | 8.3 | 8.3 | 8.3 | ***8.3*** | 11.1 | 16.7 | 8.3 | ***12.0*** | 70–79 |
| 3rd site | 22.2 | 2.8 | 2.8 | ***9.3*** | 1.3 | 0.8 | 1.3 | ***1.1*** | 2.8 | 2.8 | 2.8 | ***2.8*** | 5.6 | 8.3 | 2.8 | ***5.6*** | 50–69 |
| 4th site | 5.6 | 2.8 | 0.0 | ***2.8*** | 0 | 0.8 | 0 | ***0.3*** | 0 | 2.8 | 0 | ***0.9*** | 1.9 | 0 | 0 | ***0.6*** | 30–49 |
| 5th site | 2.8 | 0.0 | 0.0 | ***0.9*** | 0 | 0 | 0 | ***0.0*** | 0 | 0 | 0 | ***0.0*** | 0 | 0 | 0 | ***0.0*** | 10–29 |
| Nº of houses/ HHH | 2.4 | 1.3 | 1.2 | ***1.7*** | 0.4 | 0.4 | 0.3 | ***0.4*** | 0.9 | 1.1 | 0.3 | ***0.7*** | 1.2 | 1.0 | 0.9 | ***1.1*** | 1–9 |
| ***Households with lodging accommodation*** | | | | | | | | | | | | | | | | | Scale |
| % remittances | 0 | 14 | 25 | ***13*** | 22 | 14 | 19 | ***18*** | 0 | 6 | 0 | ***2*** | 6 | 3 | 0 | ***3*** | 20+ |
| % of HHs with lodgers | 2.8 | 27.8 | 19.4 | ***16.7*** | 16.7 | 19.4 | 16.7 | ***17.6*** | 5.6 | 16.7 | 5.6 | ***9.3*** | 3.7 | 5.6 | 8.3 | ***5.9*** | 15–19 |
| Nº of rooms/ landlord | 5.0 | 4.0 | 4.9 | ***4.6*** | 2.6 | 4.0 | 3.8 | ***3.5*** | 1.6 | 4.4 | 0.7 | ***2.2*** | 1.0 | 1.2 | 1.8 | ***1.3*** | 10–14 |
| | | | | | | | | | | | | | | | | | 5–9 |
| | | | | | | | | | | | | | | | | | 1-4 |

NOTE * denotes resident-owned on-site house.
SOURCE: UPIMA household survey (2012)

**TABLE 6** Education levels

| | GOLD | | | | | | | | DIAMONDS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | TANZANIA | | | | GHANA | | | | TANZANIA | | | | ANGOLA | | | | |
| Site | Ikuzi | Nyarugusu | Geita | *ALL* | Kenyasi | Prestea | Obuasi | *ALL* | Mwan-angwa | Maganzo | Mwadui | *ALL* | Luó-Itengo | Cacolo | Saurimo | *ALL* | |
| Survey HHs | 36 | 36 | 36 | *108* | 82 | 123 | 163 | *360* | 36 | 36 | 36 | *108* | 36+18 | 36 | 36 | *126* | |
| ***Head of household's level of education (%)*** | | | | | | | | | | | | | | | | | Scale |
| None | 8.3 | 13.9 | 16.7 | ***13.0*** | 17.5 | 6.7 | 6.3 | ***8.9*** | 2.8 | 25.0 | 2.8 | ***10.2*** | 25.9 | 30.6 | 11.1 | ***22.5*** | 60+ |
| Primary school | 69.5 | 80.5 | 47.2 | ***65.7*** | 22.5 | 11.7 | 6.3 | ***11.7*** | 86.1 | 63.9 | 33.3 | ***61.1*** | 14.8 | 25.0 | 50.0 | ***29.9*** | 40–59 |
| Lower secondary | 19.5 | 5.6 | 16.7 | ***13.9*** | 38.8 | 65.0 | 57.6 | ***55.9*** | 8.4 | 8.4 | 33.4 | ***16.7*** | 25.9 | 22.2 | 16.7 | ***21.6*** | 30–39 |
| Upper secondary | 0 | 0 | 0 | ***0.0*** | 17.5 | 14.2 | 22.8 | ***18.7*** | 2.8 | 0 | 0 | ***0.9*** | 33.3 | 22.2 | 11.1 | ***22.2*** | 20–29 |
| Technical training | 2.8 | 0 | 8.3 | ***3.7*** | 0.0 | 0.0 | 0.0 | ***0.0*** | 0 | 0 | 19.4 | ***6.5*** | 0 | 0 | 2.8 | ***0.9*** | 10–19 |
| University | 0 | 0 | 11.1 | ***3.7*** | 3.8 | 2.5 | 7.0 | ***4.7*** | 0 | 2.8 | 11.1 | ***4.6*** | 0 | 0 | 8.3 | ***2.8*** | 1–9 |

SOURCE: UPIMA household survey (2012)

of gaining a prosperous future than could be found elsewhere (Bryceson *et al*., 2020). However, the economic disparities and unequal human capabilities were readily apparent between countries, between settlements within countries, and between households within settlements. Living in a more economically advanced country, the Ghanaian population had a superior level of education with a majority reaching secondary level, compared to Tanzania, where primary school education represented the apex of attainment for most respondents (see Table 6). Curiously, the relatively even spread of all education levels across the Angolan artisanal mining settlements suggests that people from a broad spectrum of backgrounds migrated to the settlements with the expectation of eventual gain—a particularly alluring goal given the country's post-war context.

Inter-country comparison reveals striking differences between the existing education levels of household heads and senior females. While a small minority in each country (ranging from 10% to 23%) had no education, the majority of Tanzanians (66% and 61% at gold and diamond sites, respectively) had primary school education. In Ghana, 60% had completed lower secondary school and another 19% upper secondary. Only in Tanzania did an outlier elite of university-educated household heads surface, specifically in the urban LSM gold and diamond sites (11%). Curiously, the Angolan sample evidenced lower educational levels, but fairly evenly spread: none (23%), primary school (30%), lower secondary (22%) and upper secondary (22%). The lack of any one dominant educational cohort reflected decades of residential instability and limited state investment in education during the civil war.

Besides seeking higher earnings either directly or indirectly from mineral wealth, some residents were able to save and make investments. In Tanzania, 35% of households reported saving in the preceding year, compared to 62% of households in Ghana and 23% in Angola. At the settlement level, the incidence of household saving in Tanzania was highest (43%) in the LSM settlements, despite the cost of living being generally greater there than in other Tanzanian settlements. Households in the gold settlements were diligently saving to cover house-building costs, with the construction of many houses taking years to complete.

High levels of household savings did not necessarily translate into high levels of investment. In Ghana, 66% of households saved, but only 28% made investments, primarily in house-building (Gough *et al*., 2019). Unlike households in Angola and Tanzania, Ghanaian disposable income was being spent on an impressive array of consumer durables such as TVs and computers as well as motorbikes and occasionally cars (see Table 4). Only 16% of Angolan households made investments, most of which were directed at setting up a business. In the capital city of Saurimo, the very large number of secondary school students in the surveyed households represented youthful extended family members lodging with their urban relations to take advantage of the capital city's better schools. In effect, their schooling accounted for a large proportion of household investment, although it was not counted as such.

Of the surveyed households in Tanzania's gold and diamond settlements, 51% and 28%, respectively, made investments. In the gold settlements, over half of the investments were allocated to house construction. Other investments were targeted at agriculture and land purchases (24%) and business and trade (23%). The investment distribution pattern between settlements was fairly similar, albeit business investment in the Geita LSM site was higher than elsewhere. Farming and land purchase investments dominated (70%) in the diamond sites, reflecting a more rural-based local economy perspective.

Household food security is the most critical criterion for evaluating welfare. However, in transitional economies where food purchases are frequently combined with varying amounts of own household food production, welfare assessment becomes difficult. In Tanzania, heads of households' access to farmland averaged 83% in the gold and diamond settlements, compared to an overall average of 59% in Angola and 51%

**TABLE 7** Food security

| | GOLD | | | | | | | | DIAMONDS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | TANZANIA | | | | GHANA | | | | TANZANIA | | | | ANGOLA | | | | |
| Site | Ikuzi | Nyaru-gusu | Geita | *ALL* | Kenyasi | Prestea | Obuasi | *ALL* | Mwan-angwa | Maganzo | Mwadui | *ALL* | Luó-Itengo | Cacolo | Saurimo | *ALL* | |
| Survey HHs | 36 | 36 | 36 | *108* | 82 | 123 | 163 | *360* | 36 | 36 | 36 | *108* | 36+18 | 36 | 36 | *126* | |
| ***Household access to farmland (%)*** | | | | | | | | | | | | | | | | | Scale |
| % yes | 69 | 97 | 83 | ***83*** | 64 | 50 | 39 | ***51*** | 99 | 94 | 61 | ***85*** | 93 | 67 | 17 | 59 | 80+ |
| % at the site | 19 | 100 | 53 | ***57*** | 45 | 39 | 33 | ***39*** | 99 | 92 | 45 | ***79*** | 93 | 64 | 11 | 56 | 70–79 |
| % elsewhere | 72 | 39 | 47 | ***53*** | 31 | 17 | 14 | ***20*** | 14 | 19 | 56 | ***30*** | 11 | 3 | 8 | 7 | 60–69 |
| ***Households with food supplied from own farmland (%)*** | | | | | | | | | | | | | | | | | 50-59 |
| % yes | 61 | 94 | 69 | ***75*** | 42 | 19 | 17 | ***26*** | 86 | 94 | 56 | ***79*** | 91 | 64 | 17 | 57 | 40–49 |
| | | | | | | | | | | | | | | | | | 20–39 |
| | | | | | | | | | | | | | | | | | 1-19 |
| ***Food purchases as % of total household expenditure*** | | | | | | | | | | | | | | | | | Scale |
| <10% | 0 | 0 | 0 | ***0.0*** | 0 | 0 | 0 | ***0*** | 0 | 0 | 0 | ***0*** | 0 | 0 | 0 | ***0*** | 60+ |
| 10–19% | 2.8 | 2.8 | 0 | ***1.9*** | 11.1 | 0 | 2.5 | ***4.5*** | 0 | 2.8 | 2.8 | ***1.9*** | 0 | 0 | 2.9 | ***1.0*** | 30–59 |
| 20–29% | 5.6 | 0 | 0 | ***1.9*** | 6.2 | 4.1 | 9.8 | ***6.7*** | 0 | 0 | 2.8 | ***0.9*** | 1.9 | 0 | 2.9 | ***1.6*** | 20–29 |
| 30–39% | 2.8 | 2.8 | 0 | ***1.9*** | 14.8 | 8.9 | 14.1 | ***12.6*** | 0 | 0 | 2.8 | ***0.9*** | 0 | 2.8 | 5.8 | ***2.9*** | 10–19 |
| 40–49% | 2.8 | 2.8 | 5.7 | ***3.7*** | 11.1 | 16.2 | 13.5 | ***13.6*** | 0 | 0 | 2.8 | ***0.9*** | 0 | 11.1 | 8.8 | ***6.6*** | 5–9 |
| 50–59% | 5.6 | 13.9 | 37.1 | ***18.8*** | 16.0 | 17.9 | 17.8 | ***17.2*** | 2.8 | 8.3 | 8.3 | ***6.5*** | 5.7 | 5.6 | 5.9 | ***5.7*** | 1–4 |
| 60–69% | 13.8 | 8.3 | 8.6 | ***10.3*** | 11.1 | 22.8 | 17.8 | ***17.2*** | 2.8 | 8.4 | 5.6 | ***5.6*** | 9.4 | 0 | 8.8 | ***6.1*** | 0 |
| 70–79% | 22.2 | 30.6 | 11.4 | ***21.4*** | 9.9 | 14.6 | 8.6 | ***11.0*** | 8.3 | 25.0 | 30.5 | ***21.3*** | 9.4 | 11.1 | 20.5 | ***13.7*** | |
| 80–89% | 19.5 | 13.9 | 20.0 | ***17.8*** | 11.1 | 13.0 | 9.8 | ***11.3*** | 16.7 | 27.7 | 41.7 | ***28.7*** | 20.8 | 22.2 | 5.9 | ***16.3*** | |
| 90–99% | 25.0 | 25.0 | 11.4 | ***20.5*** | 7.4 | 1.6 | 5.5 | ***4.8*** | 69.4 | 19.5 | 2.8 | ***30.6*** | 17.0 | 11.1 | 23.5 | ***17.2*** | |
| 100% | 0 | 0 | 5.7 | ***1.9*** | 1.2 | 0.8 | 0.6 | ***0.9*** | 0 | 8.3 | 0 | ***2.8*** | 35.8 | 36.1 | 14.7 | ***28.9*** | |

SOURCE: UPIMA household survey (2012)

in Ghana. Thus, not surprisingly, the proportion of Tanzanian households with food supplied primarily from their own *in situ* farmland was high (75%).

When the above patterns are juxtaposed with respondents' reported percentage of total household expenditure spent on food purchases (see Table 7), we see that despite Tanzanian residents' proximity to farming and the availability of farmland, they spent a considerable amount of their disposable income on food purchases, especially in Mwadui, where household farming was prohibited within the residential compound of the mining company. Interestingly, all of Ghana's mining settlements had limited access to farmland compared with Tanzania and Angola. Diamond sites were more likely to have farmland close to the mining settlement site than gold sites, with the exception of the large-scale diamond mine at Saurimo in Angola.

Finally, the presence of vulnerable people with limited liquidity and living on the edge is revealed in the percentage of total household expenditure on food. The diamond sites were the most economically constrained, especially at the rush sites, where 69% of Tanzanian and 53% of Angolan residents reported spending *more than* 90% of their earnings on food.

### Agency and transitional processes in African mineralized urbanization

As evidenced in the preceding sections, the process of mineralized urbanization at our selected sites evinced different scales, tempos and outcomes, casting light on the varying influences exerted by gold vis-à-vis diamonds, different forms of mining, and the depths and richness of mineral deposits in the three countries. The different patterns exhibited between rush and mature artisanal sites relative to large-scale mining were readily apparent, and while each of those site categories revealed internal commonalities, there were in-category differences between sites. As Abu-Lughod (1975) stresses, historical timelines matter in comparative analysis. In this study, the elapse of time since the mineral discovery and the geographical specificities of individual mining locations—notably, whether they were uninhabited or already existing as settlements at the time of the discovery—precludes simple one-to-one synchronic comparison.

Nonetheless, weighing up the similarities within and between the contemporary sites, delineated into the study's three settlement types, is a useful exercise for visualizing and comprehending the different stages in the process of mineralized urbanization in African gold and diamond fields. As mineral depletion intensifies over time, population agglomeration increases, bringing the issue of labour absorption to the fore. At the outset, artisanal rush sites start small and are highly labour-intensive, characterized by a concentrated focus on mining[11] using hand-held tools.

When mineral supplies dwindle there are three main courses of action available to residents: out-migration from the site, diversifying into non-mining livelihoods, or—for those who can afford to make capital investments—the deployment of upgraded excavating machinery. At capitalized LSM sites, the highly mechanized methods of extraction reduced labour employment to negligible numbers of highly skilled labourers. As our survey data document, residents of such mining sites responded to livelihood-threatening circumstances through adaptive behaviour.

The transition from numerous artisanal rush sites to mature artisanal sites involves the ebbing away of the most unproductive and remotely located sites, resulting in a smaller number of mature sites, where excavation or the reprocessing of tailings is increasingly supplemented by commercial trading, service provision and farming. Combining farming with mining and non-mining activities enables households to remain *in situ* despite the declining returns from mining. These sites generally operate at far lower levels of commercialization than the artisanal rush and LSM sites. In the

11 Ghana was an exception, given Kenyasi's pre-existing agricultural settlement, whereas the farming reported at Angola's rush site was a euphemism for artisanal mining.

LSM towns, residents experiment with different income-generating activities to secure their livelihoods. The higher level of purchasing power in the towns relative to the surrounding countryside is a big draw for in-migration and occupational diversification, albeit the gold LSM sites are far better for potential employment than diamond settlements, which are generally far smaller and securitized, preventing in-migration.

Other adaptive behaviour is demographic in nature, involving adjustments to household size: (1) at rush sites, where smaller households of single men are willing to live in uncomfortable circumstances; (2) at mature artisanal sites, where larger households have become permanently settled due to being unable to afford to move elsewhere; or where adult male members have migrated to new rush sites, leaving their wives and children behind, as evidenced by female-biased sex ratios; and (3) in mining towns, where exceptionally large family sizes occur in households with the financial capacity to absorb extended family members eager to benefit from the better services available. This involves younger people attending secondary schools who have no possibility of doing so in their rural home areas. The flexibility of household configurations relates to the residents of mining settlements' capacity to be highly mobile.

The demographic and economic dynamism of the 2000–2013 mineral boom was most observable at the gold strike sites where artisanal miners, traders and service providers congregated. The duration of the intense activity depended on the size and geological nature of the mineral deposits and the enforcement of government policies allowing or prohibiting artisanal mining. By contrast, demographically larger and far more economically complex LSM sites, associated with corporately-owned mineral deposits, were seen as sites promising incoming migrants higher and more enduring levels of purchasing power and hence increased consumer demand. Both ASM and LSM sites sparked speculative in-migration, although many migrants subsequently became dissatisfied with their often uncomfortable lives and volatile earnings in the mining settlements. At artisanal rush sites, out-migration was common when gold and diamond pickings dwindled. In the LSM sites, we found evidence that an economically insecure underclass was evolving (Udelsmann Rodrigues and Bryceson, 2018; Bryceson *et al*., 2020).

Abu-Lughod's comparative methodology for the study of evolving urban sites—with its focus on identifying commonalities and discerning differences within and between settlements—facilitated our study of African mineralized urbanizing settlements. All 12 settlements in the three case-study countries had experienced the discovery of gold or diamonds, albeit over very different historical timelines and with varying scales of mineral endowment. This provided the material foundation for comparing and contrasting the sites' observed demographic characteristics, occupational profiles and asset holdings. Tracing their respective path trajectories revealed processes of 'becoming' urban as well as 'deurbanizing'. Both these opposing tendencies arise from the interplay of dynamic yet highly uncertain processes engendered by the population agglomeration and occupational transformation intrinsic to mineral discovery and extractive activities.

Occupationally, residents in rush sites displayed the strongest mining specialization, whilst households in intermediate-sized mature artisanal sites pursued diversified rather than specialized livelihoods. The LSM sites constituted the most populous and economically diversified occupational profiles, operating at a far higher level of commercialization and professionalism afforded by superior levels of education and training (see Table 3).

In summary, in artisanal rush sites, the welfare of residents depended primarily on mining income, whereas residents of LSM towns tended to gain their living and profit from trade and services. The latter were more likely to be able to save and invest, in the hope of gaining financial security and economic leverage. In comparison, residents of

mature artisanal mining sites, who faced downward-sloping earnings from mining, were less able to save. Across all sites, people's responses to the diminishing mining returns comprised: (1) diversification into trade/services; (2) migration to more lucrative mining sites further afield (especially apparent in Ghana); and (3) an increasing dependence on farming (common in Tanzania and Angola).

## Conclusion

Despite its importance, why has so little attention been paid to the catalytic role of mining in Africa's urbanization literature? The short answer is that there is a dire lack of adequate population enumeration from which to derive accurate estimations of mining-led population settlement (Potts, 2018). Even in African countries that undertake regularized 10-year population census-collection, the inter-census time interval is too long to capture the magnitude of settlement movement arising from short-lived local mining booms, even though these short trips can raise individuals' incomes and development horizons significantly. Sources of qualitative documentation are even more sparse. Diaries and correspondence to family back home during the Californian and Australian gold rushes of the 1850s provided invaluable documentation, which generated books, films, plays and popular culture during an era that is remembered to the present day (Goodman, 1994). By contrast, in an age of instant mobile phone messaging, there is little detailed and enduring documentation of mineralized urbanization as experienced by individuals, let alone its impact on settlements. In the absence of quantitative and qualitative evidence, survey findings provide a means of gaining some understanding of the progression of mineralized urbanization.

This article's originality stems from utilizing the concept of 'mineralized urbanization' to analyse the synergy between mineral development and urbanization in Africa. Twelve sites in Tanzania, Ghana and Angola were surveyed, where ASM or LSM of gold and diamond extraction was underway. Our comparative focus on patterns of migration, settlement type and occupational change during the global mining boom stretches from 2000 to 2013. Mining settlements at specific stages of mineral extraction display similar demographic characteristics, occupational configurations and, to some extent, levels of material consumption. Mining settlements' many population shifts and economic fluctuations propel urban growth, stability and viability, while simultaneously diminishing non-renewable mineral extractive output, which undermines the process of urban mineralization over time.

The international mining boom of 2000–2013 generated an African urbanization trajectory involving demographic, economic and social change at the settlement level. Mining booms can be significant turning points, affording both migrants and local residents livelihood opportunities they would otherwise not have had. In our three surveyed countries, the narrative of mineralized urbanization is one of miners, traders and service providers directly and indirectly earning an income from mining for material gain and household betterment before the reduction in mineral output reverses the process. Urban residents' strategies for maximizing gain and minimizing losses in the face of unpredictable mineral availability and price swings are pervasive.

The impact of the international mining boom differed markedly between the gold-mining and diamond-mining contexts and the stage of each country's mining development. Ghana's long history of gold production and trade stretches back centuries; the mineral boom boosted the economy of old gold-mining sites like Obuasi and catalysed Kenyasi as a new rush site. Tanzania's gold and diamond wealth, which had been sidelined within the country's post-independence economy, experienced an unprecedented surge of artisanal and large-scale mining during the global mineral boom. Angola, embroiled in civil war for four decades, witnessed the opposing sides drawing on its mineral wealth to fund their military campaigns until 2002. Thereafter, despite the Angolan government's ban on artisanal mining, ASM for diamonds persisted.

Meanwhile, the post-war revival of the large-scale diamond-mining sector was also being planned.

As the gold boom subsided, residents' circumstances altered. Our study ceased before this deterioration became apparent in Tanzania. In Ghana, a major gold boom had occurred in the 1980s, enabling us to observe the knock-on effects of LSM contraction and the adoption of mechanized mining. The resulting job losses led local residents to switch from formal LSM to informal ASM. In Angola, heavy LSM investment was underway. The government was intent on eradicating ASM, but it was unclear what would actually transpire.

Throughout the twentieth century, urbanization has been one of the most forceful processes for widescale change in post-colonial Africa. Rural-to-urban migration is taken for granted, and the lure of jobs in cities results in many African countries exhibiting high levels of in-migration, especially to capital cities. Henderson and Kriticos (2018) bemoan this tendency and the associated relative lack of urban industrial activities and high urban under-employment compared to other continents. However, what has been overlooked in the African urbanization literature of the twenty-first century is that 'mineralized urbanization' has been expanding livelihood opportunities and attracting population agglomeration away from the bloated capital cities.

Our survey findings revealed that local agency in response to the mining boom set in train the material development of individual lives and households. Critical levels of population agglomeration fostered economic specialization, instilling technical skills and organizational capability as well as encouraging economic livelihood expansion and diversification (Bryceson, 2014). As residents grappled with the opportunities and uncertainties of mineralized urbanization, they were able to acquire and improve their housing, educate their children better, make investments in land and property, and gain possession of desirable consumer goods and forms of transport.

Understanding mineralized urbanization necessitates a detailed study of people's attitudes, aims and active agency within their local residential context. Tracing the dynamic processes involved yields findings that can facilitate the formulation of mining policies at the regional and national levels. But above all, it is mining residents' independent drive for the self-realization of their welfare objectives through migration, settlement and occupational adaptation that shapes urban growth in the African mineralized urbanization process.

The most viable mining-related policies for government officials to pursue are ones that mitigate the environmental detriments of mining (including mercury pollution from ASM), encourage residents to save and invest their earnings for the future, and generate new skills and jobs, taking account of the eventual cessation of mineral production and subsequent mine closures. At both mature artisanal mining and large-scale sites, residents are interested in obtaining good housing and should be supported in these aims by granting building permits and encouraging house ownership. In the large-scale mining towns, a focus on better training to raise standards of house construction could help improve the housing stock. Furthermore, as part of their corporate social responsibility, mining companies should be encouraged to provide support for technical skill acquisition amongst young men and women, to help them secure future employment.

Finally, returning to Abu-Lughod's (1975) concept of 'becoming urban', we found ample evidence of its acuity in the case of mineralized urbanization. In twenty-first century Africa, mineral discovery, alongside favourable global mineral prices, ignites urbanization. Maintaining the momentum of mineralized urbanization, however, is problematic over the medium and longer term. 'Becoming urban' through the evolution of population-agglomerated settlements, household formation, occupational change, housing and infrastructural building may start to unravel when mineral

supplies and markets decline, with knock-on effects for urbanized mining areas in the form of residents' out-migration and/or scramble to find alternative sources of income. Nonetheless, the experience of mineralized urbanization sustains residents' determination to remain urban and retain urban standards of housing, consumption and aspirations. As this article has shown, the risk-taking adaptability of mining settlement residents to new conditions should never be underestimated.

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**References**

Abu-Lughod, J. (1975) The legitimacy of comparisons in comparative urban studies: a theoretical position and an application to North African cities. *Urban Affairs Review* 11.1, 13–35.

Abu-Lughod, J. (2007) The challenge of comparative case studies. *Cities* 11.3, 399–404.

Afutu-Kotey, R.L. and K.V. Gough (2022) Bricolage and informal businesses: young entrepreneurs in the mobile telephony sector in Accra, Ghana. *Futures* 135 (January). https://doi.org/10.1016/j.futures.2019.102487

Bridge, G. (2008) Global production networks and the extractive sector: governing resource-based development. *Journal of Economic Geography* 8.3, 389–419.

Bryceson, D.F. (1996) De-agrarianization and rural employment in Sub-Saharan Africa: a sectoral perspective. *World Development* 24.1, 97–111.

Bryceson, D.F. (2014) Re-evaluating the influence of urban agglomeration in Sub-Saharan Africa: population density, technological innovation and productivity. In S. Parnell and S. Oldfield (eds.), *The Routledge handbook on cities of the global South*, Routledge, London.

Bryceson, D.F. (2019) Gender and generational patterns of African deagrarianization: evolving labour and land allocation in smallholder peasant household farming, 1980–2015. *World Development* 113 (January), 60–72.

Bryceson, D.F. and J.B. Jønsson (2014) Mineralizing Africa and artisanal mining's democratizing influence. In D.F. Bryceson, E. Fisher, J.B. Jønsson and R. Mwaipopo (eds.), *Mining and social transformation in Africa*, Routledge, London.

Bryceson, D.F. and D. MacKinnon (2012) Eureka and beyond: mining's impact on African urbanisation. *Journal of Contemporary African Studies* 30.4, 513–37.

Bryceson, D.F., J.B. Jønsson, C. Kinabo and M. Shand (2012) Unearthing treasure and trouble: mining as an impetus to urbanisation in Tanzania. *Journal of Contemporary African Studies* 30.4, 631–49.

Bryceson, D.F., J.B. Jønsson and M. Shand (2020) Mining mobility and settlement during an East African gold boom: seeking fortune and accommodating fate. *Mobilities* 15.3, 446–63 .

Bunnell, T. and A. Maringanti (2010) Practising urban and regional research beyond metrocentricity. *International Journal of Urban and Regional Research* 34.2, 415–20.

Caetano, L. and M. Reis (2013) *One century of Angolan mining*. Eaglestone Securities, Lisbon [WWW document]. URL https://xmbl.files.wordpress.com/2013/10/one-century-of-angolan-diamonds-hd2.pdf (accessed 12 January 2021).

Ellis, F. and H. Ade Freeman (eds.) (2005) *Rural livelihoods and poverty reduction policies*. Routledge, London.

Fafchamps, M., M. Koelle and F. Shilpi (2016) Gold mining and proto-urbanization: recent evidence from Ghana. *Journal of Economic Geography* 17.5, 975–1008.

Flynn, K.C. (2001) Urban agriculture in Mwanza, Tanzania. *Africa* 71.4, 666–91.

Freund, B. (2007) *The African city: a history*. Cambridge University Press, Cambridge.

Geenen, S. (2016) *African artisanal mining from the inside out: access, norms and power in Congo's gold sector*. Routledge, London.

Goodman, D. (1994) *Gold seeking: Victoria and California in the 1850s.* Allen & Unwin, St Leonard's, Australia.

Gough, K.V., P. Yankson and J. Esson (2019) Migration, housing and attachment in urban gold mining settlements. *Urban Studies* 56.13, 2670–87.
Grätz, T. (2002) Gold mining communities in Northern Benin as semi-autonomous social fields. Working Paper no. 36, Max Plank Institute for Social Anthropology, Halle.
Grätz, T. (2013) The 'frontier' revisited: gold-mining camps and mining communities in West Africa. Working Paper no. 10, ZMO (Leibniz-Zentrum Moderner Orient), Berlin.
Hayes, K. (2008) *Artisanal and small-scale mining and livelihoods in Africa*. Common Fund for Commodities, Amsterdam.
Henderson, J.V. and S. Kriticos (2018) The development of the African system of cities. *Annual Review of Economics* 10.1, 287–314.
Hilson, G. (ed.) (2003) *The socio-economic impacts of artisanal mining and small-scale mining in developing countries*. A.A. Balkema, The Netherlands.
ICMM (International Council of Mining and Metals) (2012) *Mining's contribution to sustainable development* [WWW document]. URL https://www.icmm.com/en-gb/research/social-performance/mci-1-2012 (accessed 11 June 2020).
Jacques, E., B. Zida, M. Billa, C. Greffié and J-F. Thomassin (2007) Artisanal and small-scale gold mines in Burkina Faso: today and tomorrow. In G. Hilson, *Small-scale mining, rural subsistence and poverty in West Africa*, Practical Action Publishing, Rugby.
Jønsson, J.B. and D.F. Bryceson (2009) Rushing for gold: mobility and small-scale mining in East Africa. *Development and Change* 40.2, 249–70.
Jønsson, J.B. and D.F. Bryceson (2017) Beyond the artisanal mining site: mining, housing capital accumulation and indirect urbanization in Tanzania. *Journal of East African Studies* 11.1, 3–23.
Kala, M. (2016) Youth entrepreneurship in a small-scale gold mining settlement in Ghana. In K.V. Gough and T. Langevang (eds.), *Young entrepreneurs in Sub-Saharan Africa*, London, Routledge.
Lanzano, C. (2018) Gold digging and the politics of time: changing timescapes of artisanal mining in West Africa. *Extractive Industries and Society* 5.2, 253–59.
Larmer, M., E. Guene and B. Henriet (2021) *Across the Copperbelt: urban and social change in Central Africa's borderland communities*. James Currey, London.
Little, K. (1960) West African urbanization as a social process. *Cahiers d'Études Africaines* 1960/3, 90–102.
Marques, R. (2011) *Blood diamonds: corruption and torture in Angola*. Tinta da China, Lisbon.
Mayer, P. and I. Mayer (1961) *Townsmen or tribesmen: conservatism and the process of urbanization in a South African city*. Oxford University Press, Cape Town.
McFarlane, C. (2010) The comparative city: knowledge, learning, urbanism. *International Journal of Urban and Regional Research* 34.4, 725–42.
Mercer, C. (2014) Middle class construction: domestic architecture, aesthetics and anxiety in Tanzania. *Journal of Modern African Studies* 52.2, 227–50.
Mitchell, J.C. (1954) *African urbanisation in Ndola and Luanshya*. Rhodes-Livingstone Communication no. 6. Rhodes-Livingstone Institute, Lusaka.
Mususa, P. (2012) Mining, welfare and urbanisation: the wavering character of Zambia's Copperbelt. *Journal of Contemporary African Studies* 30.4, 571–87.
Myers, G. (2011) *African cities*. Zed Press, London.
Negi, R. (2014) 'Solwezi *Mabanga*': ambivalent Zambia's new mining frontier. *Journal of Southern African Studies* 40.5, 999–1013.
O'Connor, A. (1983) *The African city*. Hutchinson, London.
Parnell, S. and E. Pieterse (eds.) (2014) *Africa's urban revolution*. London, Zed Press.
Pearce, J. (2001) *Political identity and conflict in Central Angola, 1975–2002*. Cambridge University Press, Cambridge.
Pearce, J. (2004) War, peace and diamonds in Angola: popular perceptions of the diamond industry in the Lundas. *African Security Review* 13.2, 51–64.
Potts, D. (2018) Urban data and definitions in Sub-Saharan Africa. *Urban Studies* 55.5, 965–86.
Potts, D. (2015) Debates about migration and economic growth: what can we learn from Zimbabwe and Zambia? *Geographical Journal* 182.3, 251–64.
Powdermaker, H. (1962) *Copper town: changing Africa, the human situation on the Rhodesian Copperbelt*. Harper & Row, New York, NY.
Robinson, J. (2011) Cities in a world of cities: the comparative gesture. *International Journal of Urban and Regional Research* 35.1, 1–23.
Robinson, J. (2014) Comparative urbanism: introduction to a virtual issue on comparative urbanism. *International Journal of Urban and Regional Research*. URL https://www.ijurr.org/virtual-issues/comparative-urbanism/ https://doi.org/10.1111/1468-2427.12171
Udelsmann Rodrigues, C. (2017a) Urban modernity versus the blood diamond legacy: Angola's urban mining settlements in the aftermath of war. *Journal of Southern African Studies* 43.6, 1215–34.
Udelsmann Rodrigues, C. (2017b) Configuring the living environment in mining areas in Angola: contestations between mining companies, workers, local communities and the state. *Extractive Industries and Society* 4.4, 727–34.
Udelsmann Rodrigues, C. and D.F. Bryceson (2018) Precarity in Angolan diamond mining towns, 1920–2014: tracing agency of the state, mining companies and urban households. *Journal of Modern African Studies* 56.1, 113–41.
Werthmann, K. (2000) Gold rush in West Africa: the appropriation of 'natural' resources: non-industrial gold mining in south-western Burkina Faso. *Sociologus* 50.1, 90–104.
World Bank (2020) *World Development Indicators*. URL https://databank.worldbank.org/source/world-development-indicators (accessed 15 February, 2020).
Yankson, P.W.K. and K.V. Gough (2019) Gold in Ghana: the effects of changes in large-scale mining on artisanal and small-scale mining (ASM). *Extractive Industries and Society* 6.1, 120–8.