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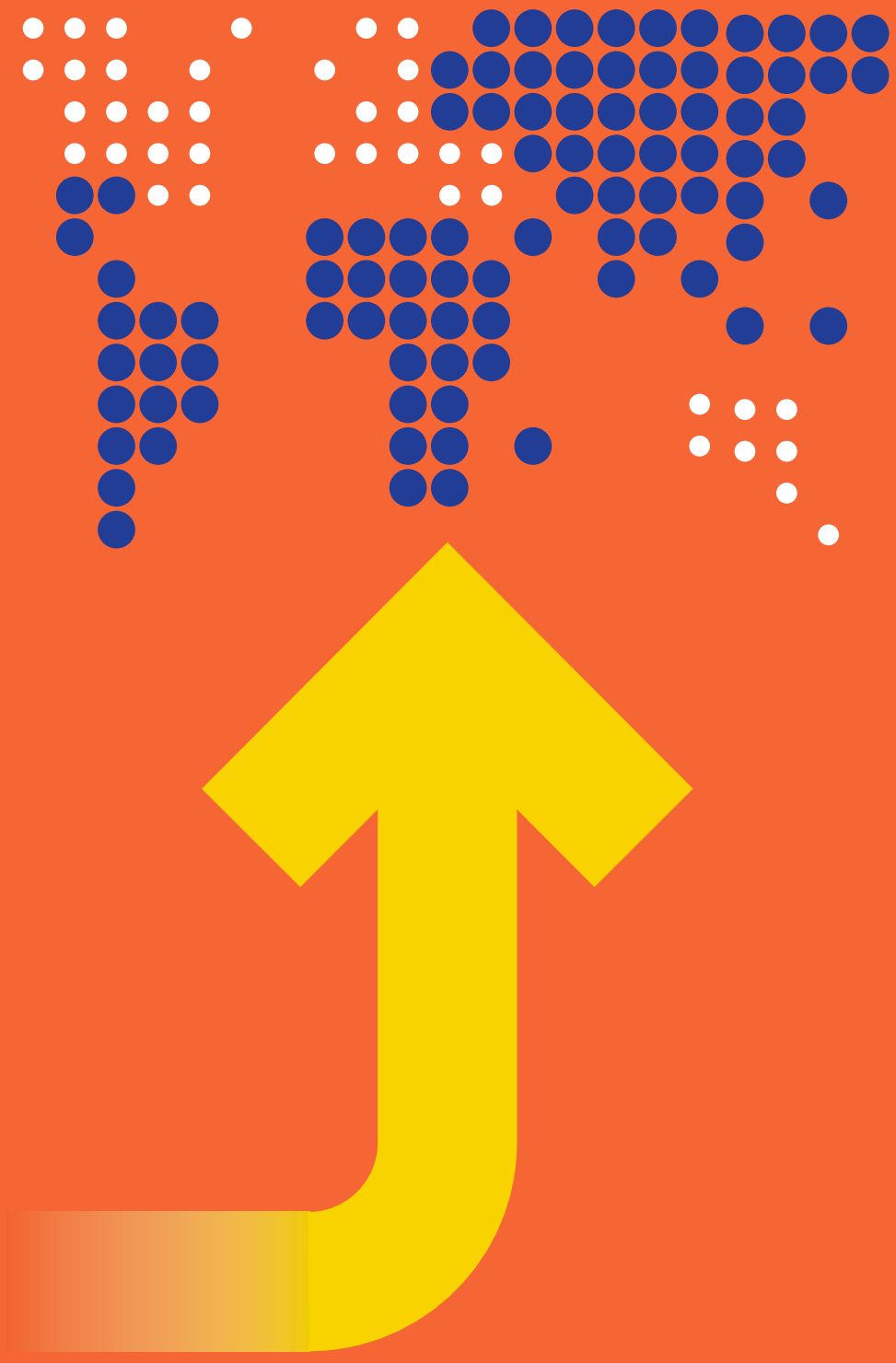
Background Paper

Demographics and Urbanization: Planning Cities That Work

Gregory K. Ingram



JICA

Emerging Markets Forum
A nonprofit initiative of the Centennial Group

Demographics and Urbanization: Planning Cities That Work

Gregory K. Ingram

Preface

Dear participants,

This paper is one of ten papers which are expected to form a book focused on imagining Africa four decades from now. Of these ten papers, five will serve as background papers for sessions at the Fifth Africa Emerging Markets Forum:

- *Imagining Africa 40 Years from Now*
- *Demographics and Urbanization: Planning Cities That Work*
- *Building Human Capital: Improving Education Quality*
- *Transforming Rural Africa: Growing a Productive Agriculture Sector*
- *Africa's Infrastructure Deficit: Closing the Gap*

Another paper, New Threats to Africa's Stability and Growth, will also be distributed at the Forum. The remaining four papers are available on the EMF website:

- *The Impact of Commodity Terms of Trade in Africa: Curse, Blessing or Manageable Reality?*
- *Africa's Inclusive Growth Challenge*
- *Economic Diversification of African Economies*
- *Regional Economic Integration in Africa*

Following this Forum, the papers will be revised and published as chapters in a book which will be widely distributed to African leaders and policymakers, among other stakeholders. As such, we will welcome your comments and feedback during and after the sessions.

Harinder Kohli
Founding Director & Chief Executive
Emerging Markets Forum

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This paper was prepared by Gregory K. Ingram.

Executive summary

Africa is a large and heterogeneous continent comprising two global regions, Sub-Saharan Africa with 53 countries, and North Africa with five. Of the 30 countries in the world ranked as low income by the World Bank, 25 are in Sub-Saharan Africa, and they currently contain about 40 percent of the region's population. All North African countries are middle income. From 2010 to 2050, Sub-Saharan Africa is projected to have the largest absolute (1.3 billion) and percentage (150 percent) increase in total population across all global regions. North Africa's population growth is the second largest in percentage terms with a projected increase of 60 percent.

The good news for Sub-Saharan Africa is that its dependency ratio is projected to fall continuously from 2010 to 2050, potentially creating a demographic dividend that can enhance economic growth. North Africa shows virtually no net change in dependency over this period. A changing demographic composition can magnify social challenges if economic growth is inadequate to provide jobs and incomes for the growing population. For example, unemployment is typically concentrated among young adults—who have higher propensities to be restive and to engage in illegal, antisocial, and risky behavior. Sub-Saharan Africa's projected population share aged from 15 through 29 is consistently high (and the highest among global regions from 2015 on). For North Africa, this age group's share is the second highest from 2030 on. This high population share of young adults could increase social instability across Africa if economic growth is low and unemployment is high.

Sub-Saharan Africa is projected to experience the largest absolute increase in urban population across all regions, but even more remarkable are the percentage increases: By 2050, Sub-Saharan Africa's urban population is projected to quadruple and North Africa's to double. The large increase in urban population projected for Sub-Saharan Africa is driven mainly by the rapid growth of its total population. A growing concern among African urban scholars is the unprecedented disconnect in recent years between increased urbanization and economic growth in many African countries.

In a random sample of 25 African cities, average urban population densities have declined by nearly 2 percent annually from 1990 to 2014—similar to the global average. If urban densities continue to decline at this rate and urban populations grow as projected, by 2050 urbanized land areas in Sub-Saharan Africa and North Africa will grow to 7.5 and 4.5 times their size, respectively, in 2000.

Expanding urbanized areas often encroach on cultivated land. Based on satellite data, the undirected expansion of urbanized land will reduce cultivated land area by 5 percent in Sub-Saharan Africa and by 9 percent in North Africa. The Food and Agricultural Organization has forecast that global cultivated land area will need to increase by 10 percent to meet food requirements in 2050—and this forecast does not take into account any loss of cultivated land to urban expansion. Undirected business-as-usual urban expansion is a potential threat to food security in Africa and elsewhere.

Metropolitan-wide planning for urban expansion and installing key infrastructure before development are critical—both to reduce development's impact on cultivated land and to avoid future retrofitting of urban infrastructure in developed areas, which typically costs three times more than installation before development. Most important is to lay out a one kilometer grid of arterial roads in areas to be developed. The lack of arterial road grids slows transport within cities, impedes the efficient operation of urban labor markets, and hinders the installation of other trunk infrastructure. Guiding urban expansion by installing infrastructure before development is a challenging priority for many countries. In 15 of 24 cities in the African sample, urban areas newly developed since 1990 lack arterial grids.

When urban infrastructure is long-lived, it is equitable to spread its cost over time. It can be partially funded from longer term public or private debt or from international aid and other transfers. Municipal development funds have supported local government loan facilities and enhanced

New technology embodied in the concept of the smart city has the potential to address many problems faced by African cities that stem from rapid population growth and climate change.

local urban government borrowing capacity. Some middle-income countries, including South Africa, have issued municipal bonds. Private participation in infrastructure has been a growing finance source over the past 25 years and has played a very important role in the rapid expansion of mobile telephone service in Africa. Since 2006, private investment in infrastructure has been four to six times larger than combined overseas development assistance and World Bank funding allocated to infrastructure.

Metropolitan infrastructure investment will require local funds to fund investment directly or to repay debt. Lack of local revenue is a major issue in African metropolitan areas and municipalities. The property tax is inherently attractive local revenue source because real estate benefits from local services and is immovable, making the tax difficult to evade. Moreover, its scope can be extended to include value capture, which taxes increased land value associated with new infrastructure investments. User fees and benefit charges create appropriate incentives for both suppliers and users of services, but the fees must be set at an appropriate level. Fees that are below costs promote overuse of services—a serious problem in electric power and water, where subsidized rates stimulate demand for services and hence for more investment. Recent estimates are that Sub-Saharan Africa governments spent $4.1 billion annually (0.7 percent of GDP) on power and water subsidies.

Both rural and urban areas will be adversely affected by results of climate change—from increases in average temperatures across the continent, less rainfall in northern and southwestern areas, and increasingly stressed water systems everywhere. Such results are likely to harm the extensive rain fed agriculture that supports much of the rural population, contributing to the growth of urbanization. Projections of more severe weather events will continue the dramatic increase in the frequency of floods in Africa since 1960. Local government capacity to adapt to climate change threats is often weak, data are fragmentary, and infrastructure inadequate. While local governments have been addressing climate change issues, most adaptations remain uncoordinated and reactive to short-term problems. The challenge is to promote urban economic growth and to devote a sufficient share of that growth to investments in infrastructure and in metropolitan-area public goods so that infrastructure service coverage can increase and events associated with climate change become less life-threatening and costly to urban residents.

New technology embodied in the concept of the smart city has the potential to address many problems faced by African cities that stem from rapid population growth and climate change. The relative lack of urban infrastructure and physical assets could be an advantage, allowing cities to leapfrog directly to new technologies unconstrained by legacy stocks of aging and obsolete facilities. Smart city technology involves integrating information technology into the expansion, management, and operation of the city and its infrastructure in order to improve operating efficiency or to transform or replace existing systems. Along with great promise, this technology poses many challenges including loss of privacy, scale economies that could stifle competition, and the risks of systemic failure. One early lesson: cities that have responded to proposals from private vendors in an ad hoc fashion have not done as well as cities that first developed a technology vision or plan.

To handle successfully the projected large increases in total and urban populations and the unprecedented expansion of urbanized areas over the next 40 years, African countries must pursue national policies that promote economic growth, health care, and education within a supportive macroeconomic and regulatory framework. With a sound national framework, the success of cities and metropolitan areas will be determined to a great extent by policies pursued at the metropolitan and municipal level—including planning for urban expansion and provision of basic infrastructure services. Sound national policies are necessary, but not sufficient, for success at the metropolitan level. Within a supportive national policy, metropolitan areas can underperform by pursuing poor policies. But with

National governments and metropolitan areas need to work together to manage an effective transition to an urbanized African society.

poor national policies, even excellent policies at the metropolitan level are unlikely to succeed. National governments and metropolitan areas need to work together to manage an effective transition to an urbanized African society.

Demographics and Urbanization: Planning Cities That Work

Introduction[1]

Africa, a large and heterogeneous continent, is experiencing high population growth and rapid urbanization. This paper reviews the interactions between Africa's total and urban population growth, highlights the key challenges posed by projected demographic changes, develops the implications that urban population growth has for the physical expansion of its cities, and relates such physical expansion to the investment in, and financing of, needed urban infrastructure. The paper also surveys the substantial challenges that climate change poses for urban growth in Africa and assesses how new technology associated with smart cities may help address Africa's looming urban growth and climate change issues. This analysis sometimes subdivides Africa into North Africa, comprising the five middle-income countries on its Mediterranean coast, and Sub-Saharan Africa, comprising the remaining 53 countries. Data are also examined from all of Africa's 58 countries and from a random sample of 25 African cities. The two regions are compared with seven other global regions to offer a global perspective, while data on individual countries and cities underpin more detailed analyses.

After placing Africa in the global context in terms of its current population, urbanization, and income; U.N. population projections from 2010 to 2050 are reviewed. Africa will have the largest regional increase in total and urban population—both absolutely and in percentage terms—over the forecast period. Africa's increase in total population is a key driver of its urban population increase. Its high rate of population growth makes it the only global region experiencing a declining dependency ratio,[2] which potentially can yield a demographic dividend spurring economic growth. At the same time, the population's share of young adults will remain very high, potentially threatening social stability if adequate economic growth is not realized. National and municipal policies likely will have little if any effect on these demographic trends in the short or medium run, due to the built-in demographic momentum.

Recent global trends in urbanization suggest that growing urban populations will expand urban areas greatly because urban population densities will continue to decrease, causing urbanized areas to grow at rates much higher than urban populations. Urban expansion will create tremendous needs for infrastructure investment. Installing a basic grid of arterial roads before urban development occurs is a high priority. Such a grid can guide urban development away from cultivated land, provide rights of way for transit and trunk utilities, improve urban productivity, and do so at less cost than the inevitable later efforts to retrofit infrastructure. Financing infrastructure will require new borrowing approaches and municipal finance reforms that enhance local revenue mobilization.

Climate change will have large impacts on Africa and its cities, causing increased stress on water systems throughout the continent and even speeding the movement of people from country to city in some areas. New infrastructure facilities need to take account of its effects. Smart city technology has the potential to improve the efficiency of existing infrastructure and make new infrastructure more productive. Africa's rapidly growing use of mobile phones and associated innovative applications are potential precursors of the benefits of new technology for cities.

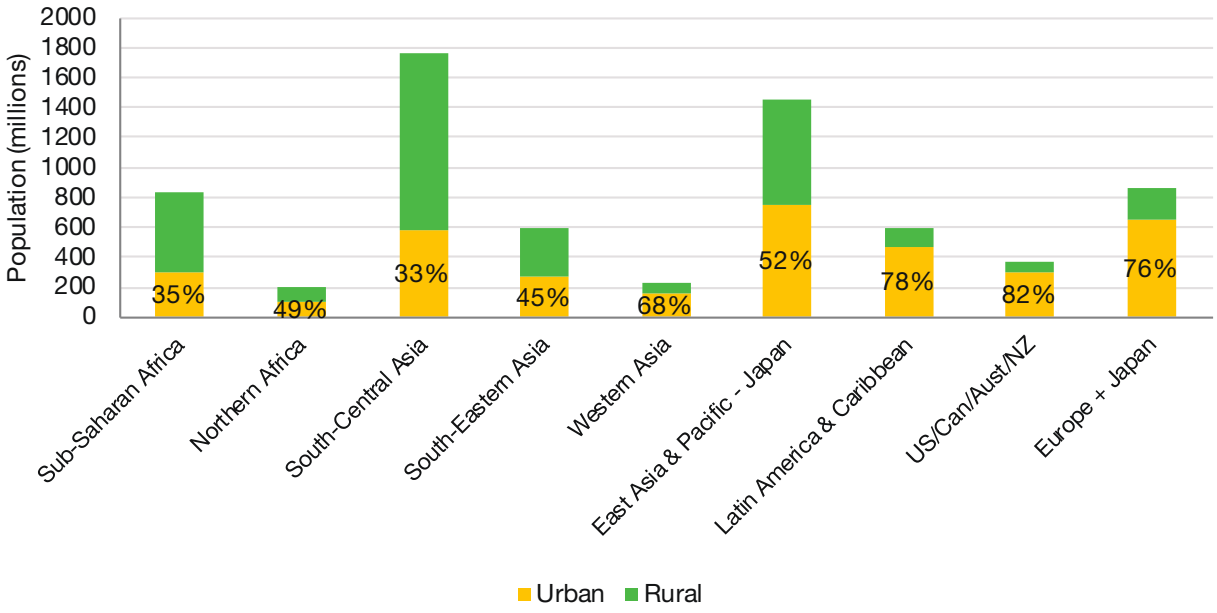
Current population and income levels

Figure 1 provides a global context by displaying the 2010 populations for nine global regions (seven developing and two high income).[3] Sub-Saharan Africa ranks fourth in terms of 2010 population, and its urban population share is second lowest, just above that of South-Central Asia. North Africa is the smallest of the nine regions, and half its population is urbanized.

1. The author thanks H. Kohli, T. Ahlers, and B. Ormond for comments, and has drawn ideas from Ingram (2016).
2. Dependency ratio is discussed further below.
3. These nine regions are similar to those used by the United Nations, except that Japan has been grouped with Europe, and four high-income, land-rich countries (Australia, Canada, New Zealand, U.S.A.) have been grouped separately. See Annex 1 for country groupings.

Sub-Saharan Africa is projected to have the largest absolute (1.3 billion) and percentage (150 percent) increase in total population across regions, so that by 2050 its total population will be second only to South-Central Asia and well ahead of East Asia.

Figure 1: Population and urban share, by region (2010)



Source: UN (2014. 2015)

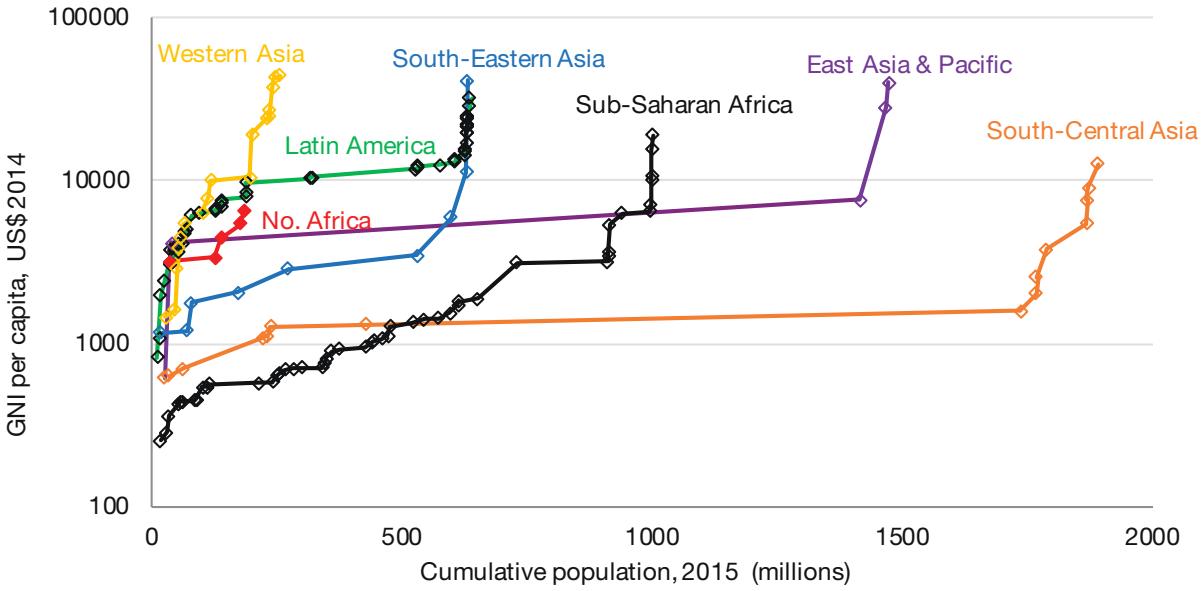
Figure 2 presents information on current country population and income for all countries in the seven developing regions. It displays the cumulated country populations by region with the countries ranked by per capita Gross National Income (GNI). Many of the 53 Sub-Saharan Africa countries are low income (GNI per capita less than US$1,045 in 2014). The Sub-Saharan region contains 25 of the 30 countries ranked as low income by the World Bank, and these 25 countries currently hold about 40 percent of the region's population. The Latin America and Caribbean region also contains a large number of countries (43), but, unlike Sub-Saharan Africa, many of its small countries are middle or high income. It includes only one low income country, Haiti. South-Central Asia, dominated by India, is also a poor region, but it has only two low income countries, Afghanistan and Nepal, representing about 3 percent of that region's population. The East Asia and Pacific region has two low income countries, Cambodia and North Korea. North Africa is fairly homogeneous in terms of income, and all countries in that group are middle income. Referring back to Figure 1, the two regions with the lowest shares of urbanized population—South-Central Asia and Sub-Saharan Africa—are the poorest in Figure 2, reflecting urbanization's typical relation with income.

Projections of total populations to 2050

Planning for development requires projections of population growth; the projections used here are from the United Nations' most recent estimates for national (2015) and urban (2014) populations. Figure 3 shows 2010 total populations and projected regional populations for 2050. Sub-Saharan Africa is projected to have the largest absolute (1.3 billion) and percentage (150 percent) increase in total population across regions, so that by 2050 its total population will be second only to South-Central Asia and well ahead of East Asia. While the absolute population growth of North Africa is modest, it is tied for second in percentage terms with a projected 60 percent increase.

Lower income countries have high annual projected population growth rates—most ranging from 2 to 3 percent—while middle income country rates center around one percent.

Figure 2: Developing regions: Cumulative country population by ascending GDP per capita



Source: World Ban k (2016), UN (2015)
Note: Based on gross national income per capita in 2014. The World Bank income groups are: low income, $1,045 or less; lower middle income, $1,046-4,125; upper middle income, $4,126-12,735; and high income, $12,736 or more. Of the 30 low income countries, 25 are in Sub-Saharan Africa.

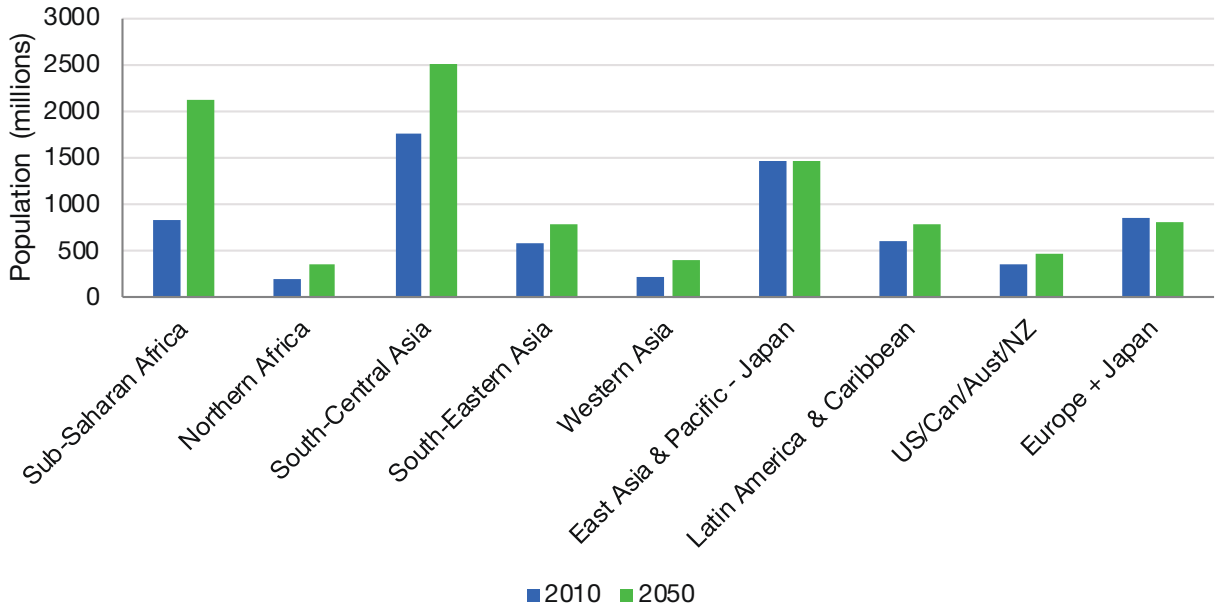
The East Asia region, second largest in 2010, is projected to have essentially no overall population growth to 2050, while the population of Europe plus Japan declines because of the rapidly aging populations in both regions. The land-rich high income group (US/Canada/Australia/New Zealand) is projected to experience moderate growth (up 27 percent) with international immigration making an important contribution.

Projected population growth varies inversely with current country GDP per capita at the aggregate level. Figure 4 shows this correlation using average per capita GDP and growth rates for the World Bank's four income groupings. Projected annual population growth falls steadily across the three lowest income groups, from 2.3 to 1.1 to 0.3 percent. There is virtually no difference in projected growth rates between upper middle and high income groupings. Figure 4 also shows the averages for the Sub-Saharan and Northern Africa regions. These two regional averages reflect the income group pattern but with above average population growth for their current income groups.

Figure 5 shows projected population growth and current GDP per capita at the country level for the Sub-Saharan and Northern Africa regions combined and reveals substantial variation around the underlying averages. Lower income countries have high annual projected population growth rates—most ranging from 2 to 3 percent—while middle income country rates center around one percent. The few outliers (high incomes and high growth rates) are labeled, and their situations are enlightening: Angola, Equatorial Guinea, and Gabon are oil exporters with high GDP per capita and very unequal income distributions. But in general, higher incomes are associated with lower population growth.

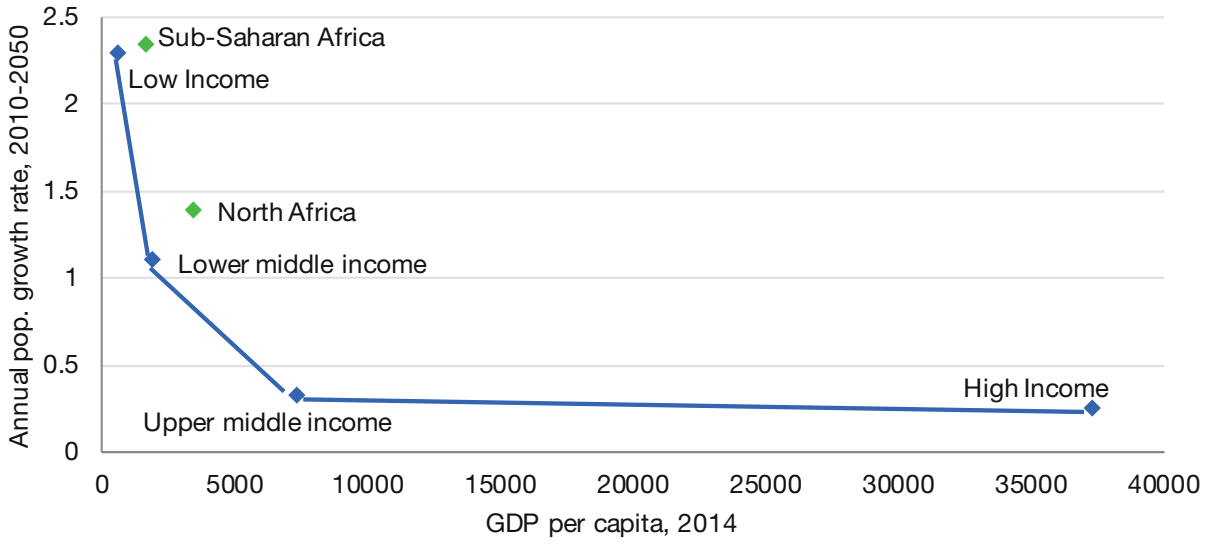
The good news for Sub-Saharan Africa is that its dependency ratio falls continuously over this period, potentially creating a demographic dividend that will enhance economic growth.

Figure 3: **Population by region: 2010 & projected 2050**



Source: UN (2015)

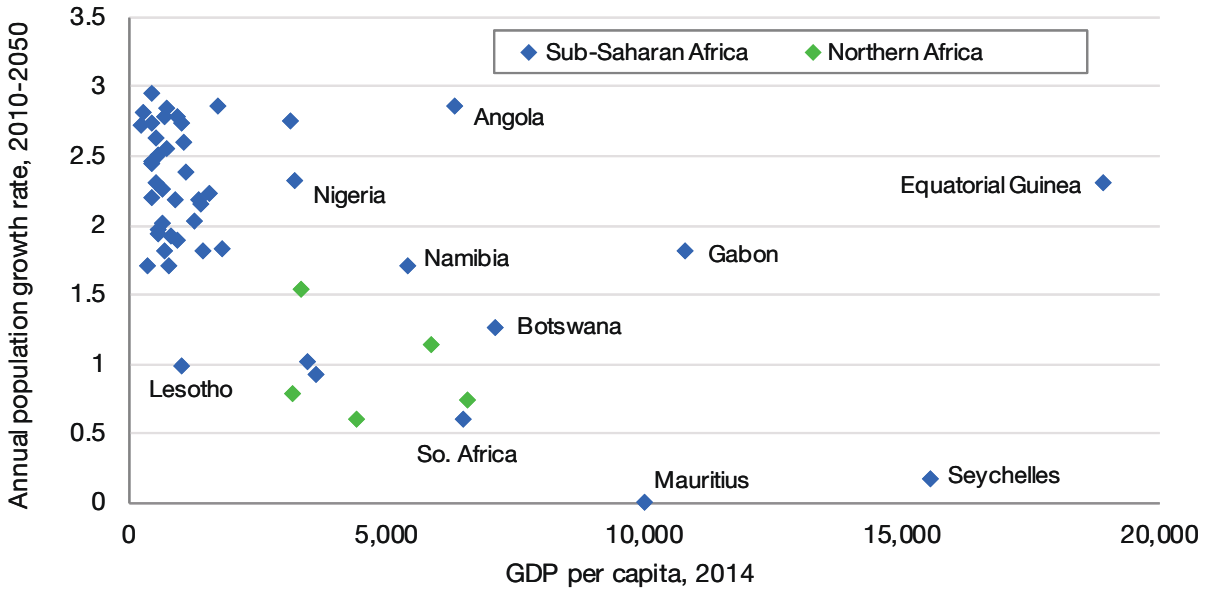
Figure 4: **Projected population growth and current income**



Source: UN (2015); World Bank (2016)

Underlying the trend in Sub-Saharan Africa is the projected reduction in birth rates, reducing the share of the population 14 and younger well before the proportion 65 and older increases.

Figure 5: Projected country growth and current income



Source: UN (2015); World Bank (2016)

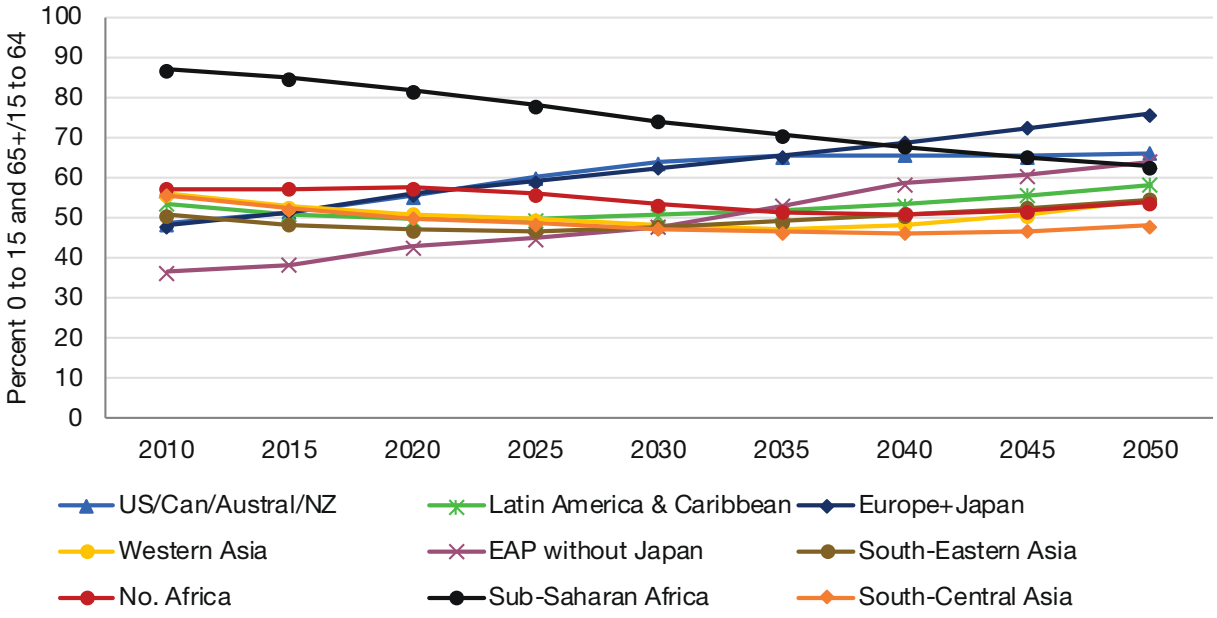
Projected changes in demographic composition

The demographic composition of country populations will change in important ways from 2010 to 2050. The dependency ratio measures the ratio of "dependents" (those aged 0 through 14 plus those aged 65 and older) to the working age population (those aged 15 through 64) and so measures the economic burden that dependents place on an economy. High or rising dependency ratios are characterized as a headwind to economic growth; falling dependency ratios are characterized as a demographic dividend that facilitates economic growth. High dependency ratios can result from high birth rates (a growing share 14 and younger) or from increases in life expectancy and aging populations (a growing share 65 and older). Figure 6 shows projected dependency ratios from 2010 to 2050 by global region. The ratios increase continuously for Europe plus Japan and East Asia, and increase and then flatten for the US/Canada/Australia/New Zealand—reflecting the aging populations of those regions. The good news for Sub-Saharan Africa is that its dependency ratio falls continuously over this period, potentially creating a demographic dividend that will enhance economic growth. North Africa shows a modest decline followed by an increase over this period with little net change. Underlying the trend in Sub-Saharan Africa is the projected reduction in birth rates, reducing the share of the population 14 and younger well before the proportion 65 and older increases.

Figures 7 and 8 present data on the net change in dependency ratios from 2010 to 2050 by income group for the two Africa regions (Figure 7) and for each country in Sub-Saharan and North Africa combined (Figure 8). The patterns are similar to those in Figures 4 and 5 relating population growth to GDP per capita. The low income country group experiences a substantial demographic dividend; the lower middle income country group, a nearly neutral impact; and the upper middle and high income country groups experience substantial demographic headwinds

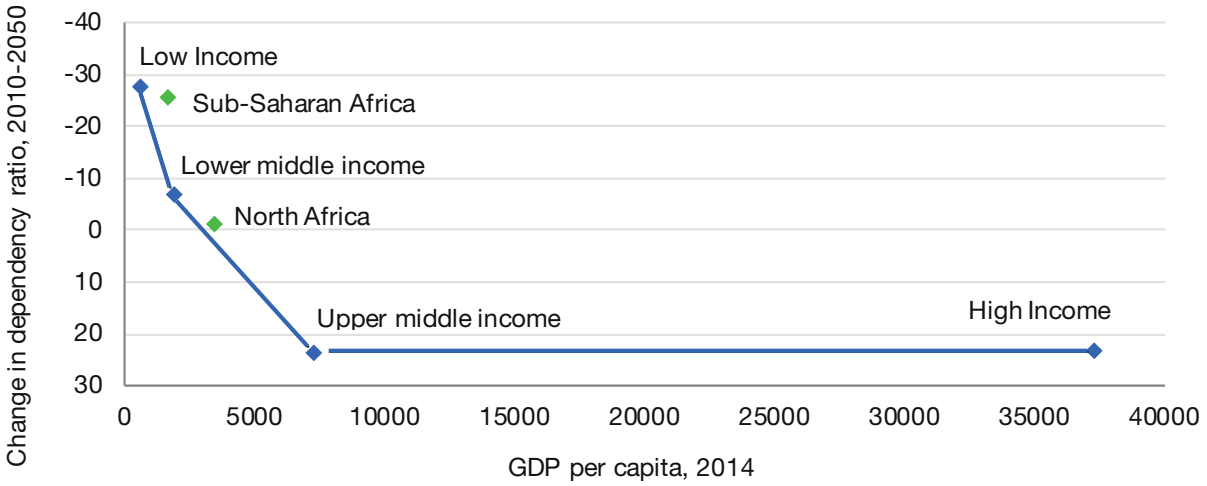
Starting in 2015, the projected percent of the population aged 15 through 29 in Sub-Saharan Africa is the highest across regions.

Figure 6: Dependency ratios by region



Source: UN (2015)

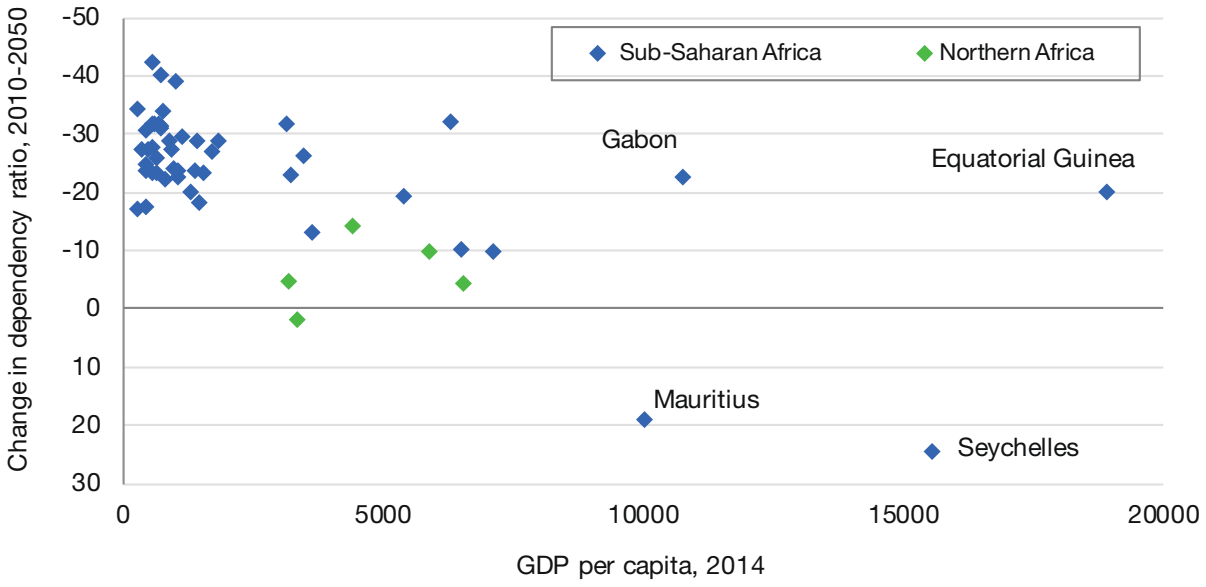
Figure 7: Projected change in dependency ratio and current income



Source: UN (2015); World Bank (2014)

While the demographic dividend that Sub-Saharan Africa will experience is positive, the high young adult population share could create problems if economic growth is low and unemployment is high.

Figure 8: Dependency ratio change, 2010-2050, and current income



Source: UN (2015); World Bank (2014)

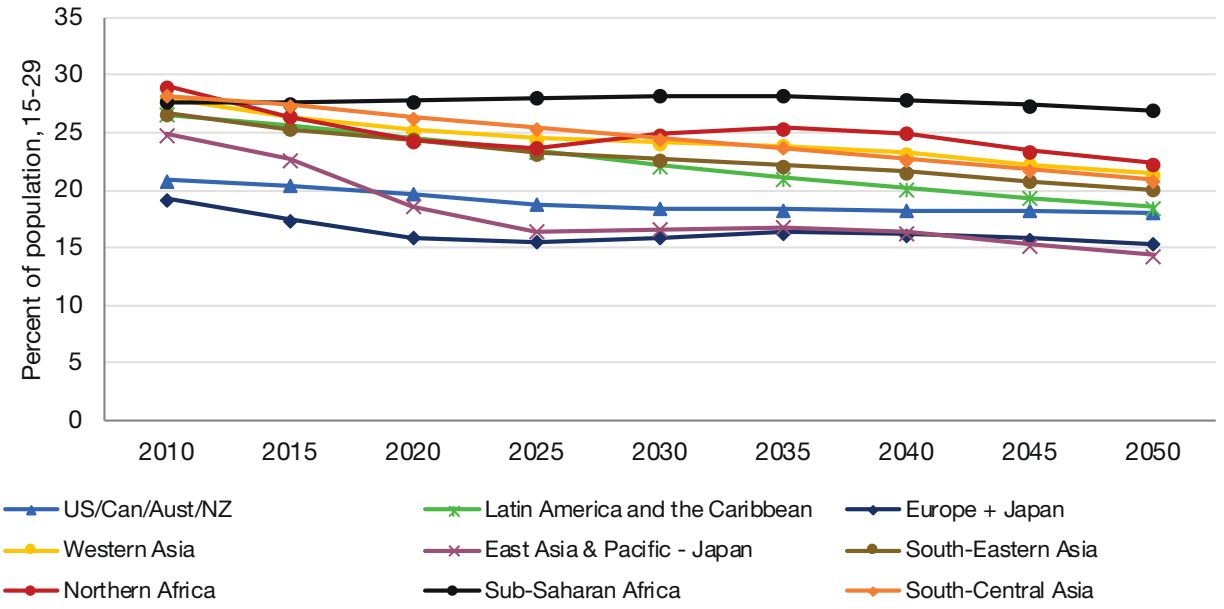
from increased dependency ratios (Figure 7). The net changes shown in Figure 8 at the country level are varied, but they are clustered around the income group averages.

While a falling dependency ratio can produce a demographic dividend that aids growth, it can also create social challenges if economic growth is inadequate to provide jobs and incomes for the growing population. Unemployment is normally concentrated among younger workers, and young adults also have higher propensities to be restive and engage in illegal, antisocial, and risky behavior. The young adult share of the population can be measured directly as a "restiveness ratio;" Figure 9 shows the share of each region's population aged from 15 through 29, from 2010 to 2050. If growth is insufficient to keep unemployment rates down, civil unrest and domestic security issues are likely to be greater when this share is large.

The striking result is that, starting in 2015, the projected percent of the population aged 15 through 29 in Sub-Saharan Africa is the highest across regions. For North Africa, the young adult share is the highest in 2010, falls, and then rebounds to be the second highest from 2030 on. This demographic feature will be a challenge for the whole African continent and is the potential downside of Sub-Saharan Africa's demographic dividend. Meanwhile, the young adult share decreases for all other regions—most dramatically for East Asia, where the percentage is similar to that of Europe+Japan by 2025 and eventually falls below it by 2050. While the demographic dividend that Sub-Saharan Africa will experience is positive, the high young adult population share could create problems if economic growth is low and unemployment is high. It is unlikely that national or local policies will have much effect on Africa's overall population growth or the projected changes in the demographic composition of its population over this time period.

Sub-Saharan Africa's urban population is projected to grow by close to 300 percent—nearly quadrupling from the level in 2010. North Africa's projected gain is 100 percent—a doubling of 2010 urban population.

Figure 9: Young adult population share by region, 2010-2050



Source: UN (2015)

Projected increases in urban populations

The growth in total populations has significant economic impacts, but so does the growth of population in urban areas. Figure 10 shows the absolute change in total and urban population by region from 2010 to 2050. In most regions except Sub-Saharan Africa and North Africa, the urban population increases by more than the total population—implying that the rural population will decrease absolutely (and the most in East Asia). Sub-Saharan Africa is projected to experience the largest absolute increase in urban population across the regions.

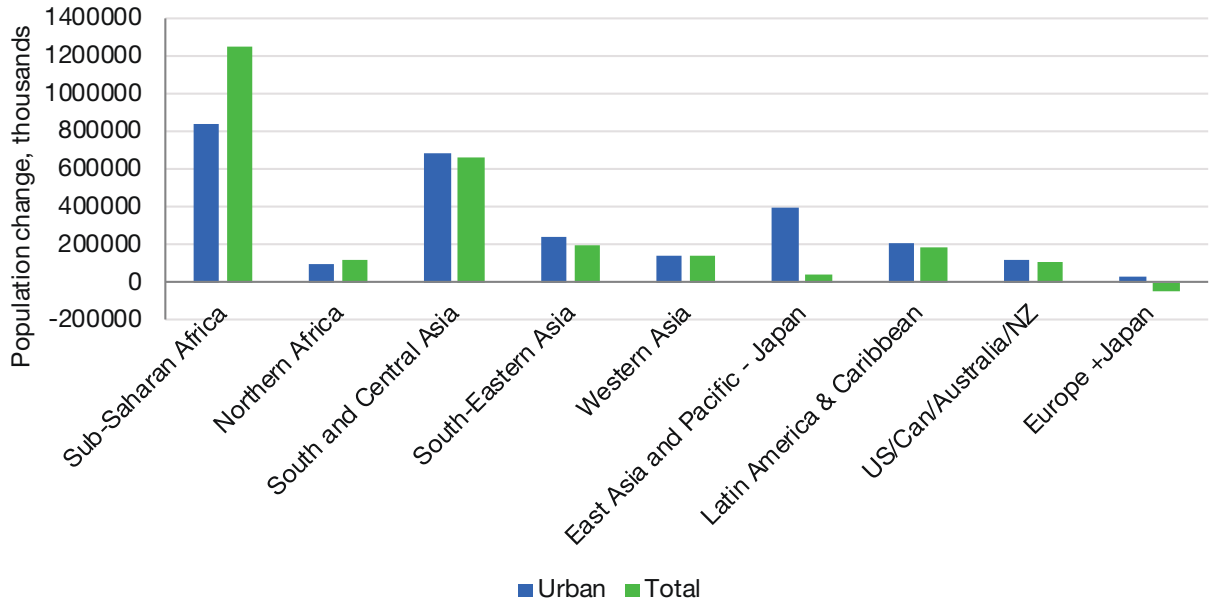
The projected absolute increases in urban population are large, but even more remarkable are the percentage increases. Figure 11 shows that Sub-Saharan Africa's urban population is projected to grow by close to 300 percent—nearly quadrupling from the level in 2010. North Africa's projected gain is 100 percent—a doubling of 2010 urban population. The percentage increase projected for Sub-Saharan Africa's urban population is unprecedented.

Another perspective on urban population growth is the change in the share of total population over time that is urban. Shown in Figure 12 for each region, the pattern is one of smooth and steady progression for most regions. One exception is East Asia, whose urbanization is projected to accelerate and then slow over the next few decades. Sub-Saharan Africa and South Central Asia, the two poorest regions, have the lowest urban population shares throughout the period, and each reaches or exceeds 50 percent from 2040 to 2045. The declining difference in urban population shares over time illustrates a pattern of convergence across regions. Figure 12 makes it clear that the large increase in urban population projected for Sub-Saharan Africa is driven mainly by the large increase projected for its total population because its urban population share grows in a very regular manner—similar to that of most other regions.

Figure 12 also provides global evidence that increases in urban population shares tend to be larger for poorer and

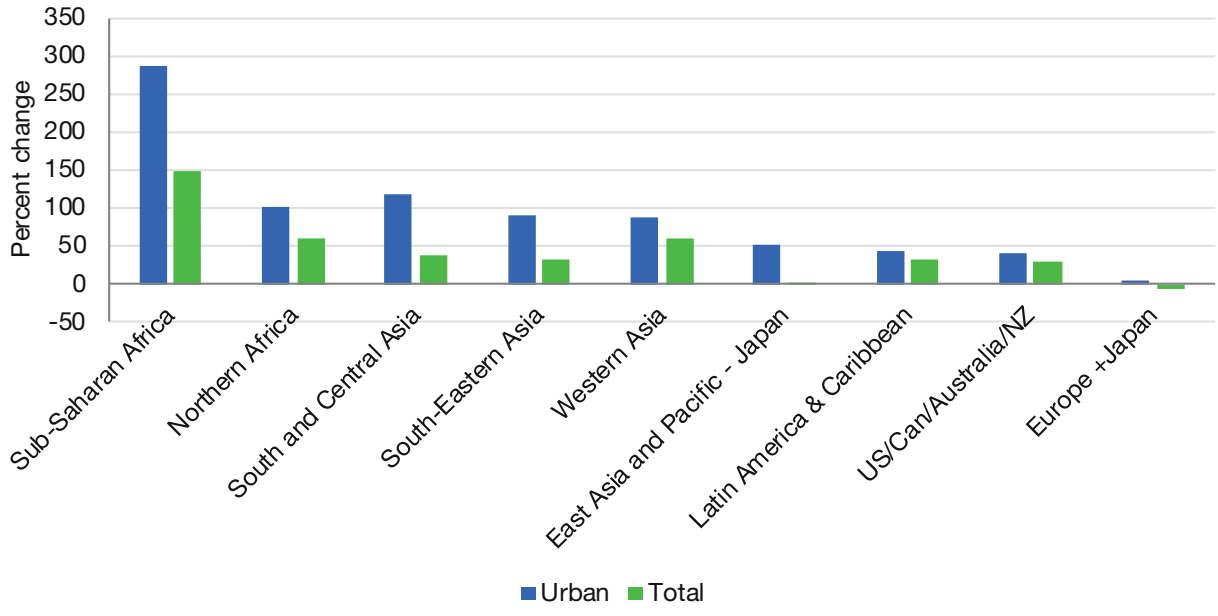
The large increase in urban population projected for Sub-Saharan Africa is driven mainly by the large increase projected for its total population because its urban population share grows in a very regular manner—similar to that of most other regions.

Figure 10: Population change, urban and total, 2010 to 2050



Source: UN (2014)

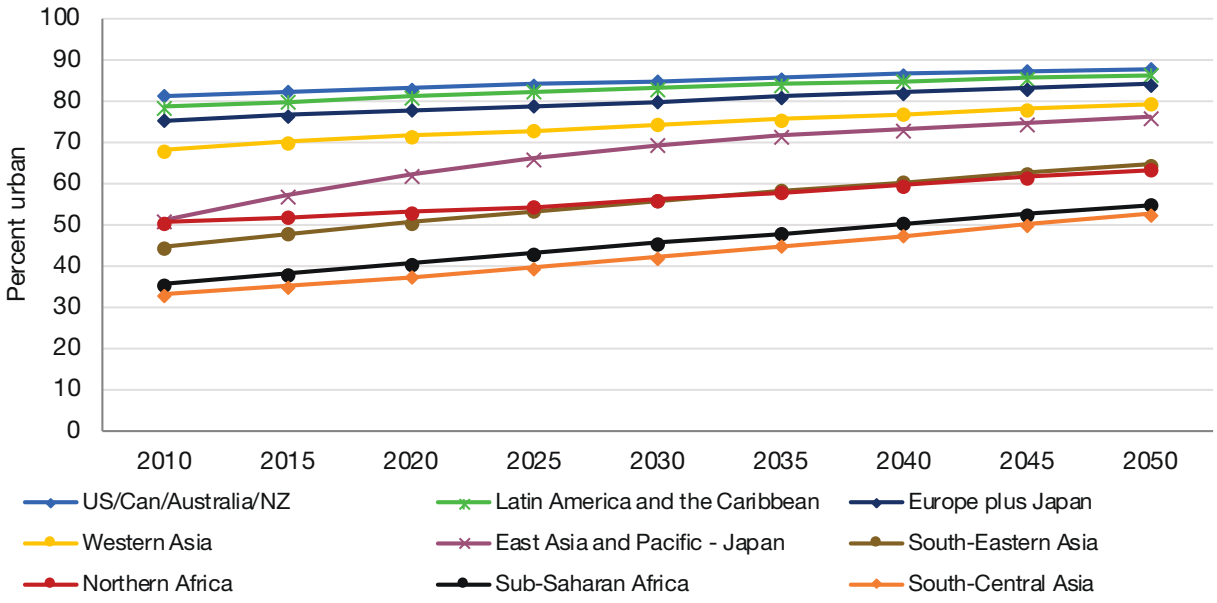
Figure 11: Percent change in population, urban and total, 2010 to 2050



Source: UN (2014)

A growing concern among African urban scholars is the globally and historically unprecedented disconnect between increased urbanization and economic growth in many African countries

Figure 12: Percent urban by region



Source: UN (2014)

less urbanized regions. This pattern is also observed in Africa— Figure 13 relates each country's projected change in the percent of its urban population from 2010 to 2050 to its current income. Low income tends to be associated with higher increases in projected urbanization, consistent with an overall pattern of convergence. In recent decades, however, a growing concern among African urban scholars is the globally and historically unprecedented disconnect between increased urbanization and economic growth in many African countries (OECD, 2016; Gore, 2015). A continuation of this disconnect, combined with the high share of the population aged 15 through 29, is likely to produce social unrest.

Urban population densities

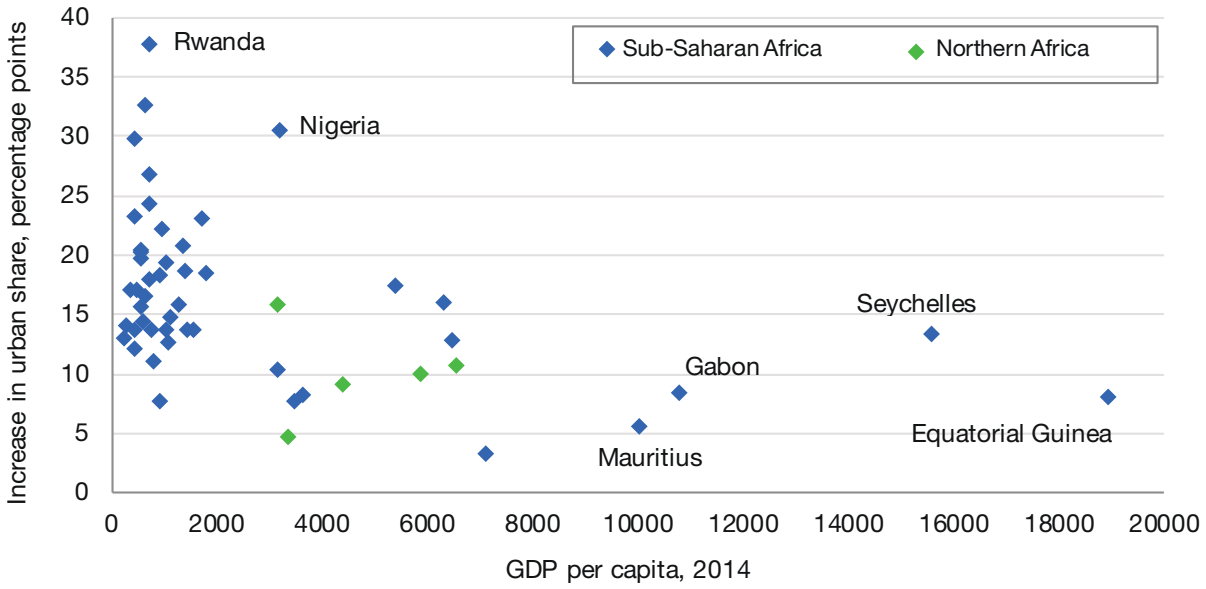
Improvements in the use of satellite imagery and data now allow the identification of urbanized land as distinct from forests, crop land, or other uses. Moreover, satellite data allows consistent definition of urbanized areas across countries and over time.[4] These estimates of urban areas combined with urban population data allow measurement of urban population density and its change over time for individual cities. Population density is an important parameter because it allows the transformation of forecasts of urban population growth into projections of the physical growth of urbanized areas. The expansion of urban areas is a key input for planning transport, utilities, and other infrastructure investments.

Shlomo Angel and his colleagues have recently compiled data on urbanized areas and urban densities at decadal intervals (approximately 1990, 2000, and 2014) for a random sample of 200 global cities drawn from the global total of 4,245 cities with 2010 populations over 100,000 (Angel, Blei & et al., 2016). This random sample includes 25 cities from Africa.[5] Angel and his colleagues have examined changes in urban densities over two decades for this

4. For a description of the analysis, see Angel (2012).
5. The 25 cities are listed in Annex 2.

The average annual rate of decline of population densities across all 25 African cities from 1990 to 2014 was 1.83 percent, a result that is close to the long term global average of two percent.

Figure 13: Increase in urban population share and current income



Source: UN (2015); World Bank (2014)

global sample of 200 cities and also over much longer periods of time for select U.S. and global cities (Angel, et al., 2012). They found that, over long periods of time, urban population densities have declined about two percent per year on average, with variation around this mean.

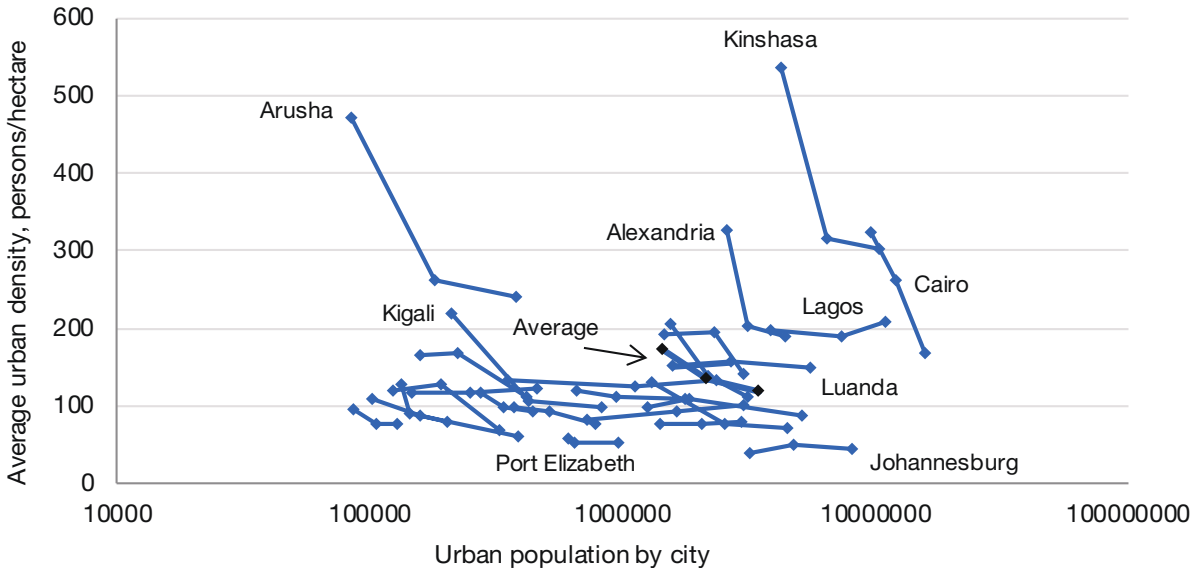
How does this compare with the experience of African cities? Population density and population size for the 25 African cities are shown in Figure 14, along with the sample averages. The population of all cities grew over this period, so for each city the 2014 density is the right-most point. Urban population densities decreased over the period for 19 of the 25 cities. The exceptions were Bamako, Ibadan, Johannesburg, Kampala, Lagos, and Oyo (interestingly, three of these are in Nigeria). Cities with high population densities experienced the largest decreases; in 2014, the sampled city densities ranged from 50 to 250 persons per hectare—down from 50 to 550 in 1990. The average annual rate of decline of population densities across all 25 African cities from 1990 to 2014 was 1.83 percent, a result that is close to the long term global average of two percent reported by Angel.

Projected increases in urbanized land area

One often overlooked aspect of urban population growth is the expansion of urbanized land area that accompanies increases in urban populations. Extensive analysis of both historical and satellite data, including the review of experience in 25 African cities above, indicates that urban population densities have declined by about two percent per year over the last century. A rough rule of thumb is that a doubling of urban population is associated with a tripling of urbanized land (Angel, 2012). Figure 15 presents data on urban land cover by region in 2000; it shows that across regions urban land cover occupied less than one percent of the land area in all nine regions, with particularly low shares for Sub-Saharan Africa and North Africa, 0.12 and 0.15 percent respectively. Figure 15 also presents two forecasts of the urbanized land area in 2050 based on

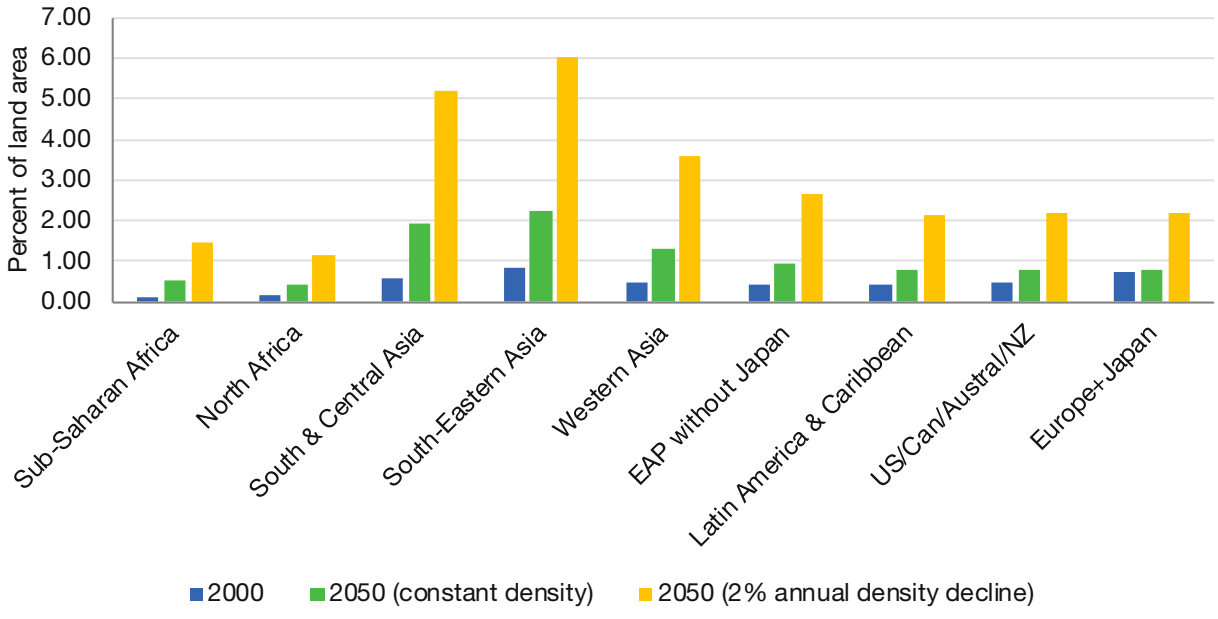
With declining densities, by 2050 urban land areas in Sub-Saharan Africa and North Africa grow to 7.5 and 4.5 times their size, respectively, in 2000.

Figure 14: Population density, 1990, 2000, & 2014 for 25 African cities



Source: Angel, Blei & et al. (2016)

Figure 15: Urban land cover share of total land area, 2000 and 2050



Source: Angel (2012), calculated from Table 10.2, p. 166 and Table 15

The lack of arterial road grids makes transportation within cities difficult, impedes the efficient operation of urban labor markets by increasing the costs of commuting, and hinders the installation of other trunk infrastructure—thereby increasing the cost of water, electric power, and other networked utilities.

the projected urban population increases in Figure 10. The first makes the very conservative assumption that average urban population densities in each region remain the same in 2050 as in 2000, and the second assumes that urban population densities will continue their historic trend of declining by 2 percent per year.

With constant urban population densities, urban land areas in Sub-Saharan Africa and North Africa will grow to 4.5 and 3 times their size, respectively, in 2000 (0.54 and 0.42 percent of total area). With declining densities, they grow to 7.5 and 4.5 times their size, respectively, in 2000 (0.9 and 0.68 percent of total area). While the absolute size of these expansions is less than those projected for other regions, the large percentage increases have important implications for the expansion of urban areas and associated infrastructure in Africa.

When urbanized areas expand, they often encroach on cultivated land. Satellite data allows the identification of cultivated land, so it is possible to develop rough estimates of the extent to which urban growth subsumes cultivated land. Figure 16 shows the regional share of cultivated land in 2000 that would be lost to urban expansion by 2050—with the simplifying assumption that urban areas will expand over land uniformly in all directions (like inflating a balloon) and the assumption that urban population densities continue to decline at historic rates of two percent per year. The share is particularly large for North Africa (over 9 percent) but also of concern for Sub-Saharan Africa (at 5 percent). To put these numbers in perspective, the Food and Agricultural Organization (FAO) has forecast that global cultivated land area will need to increase by 10 percent by 2050 to meet food requirements at that time (FAO, 2012). This FAO forecast does not take into account any loss of cultivated land to urban expansion, so undirected business-as-usual urban expansion is a potential threat to food security in Africa and elsewhere.

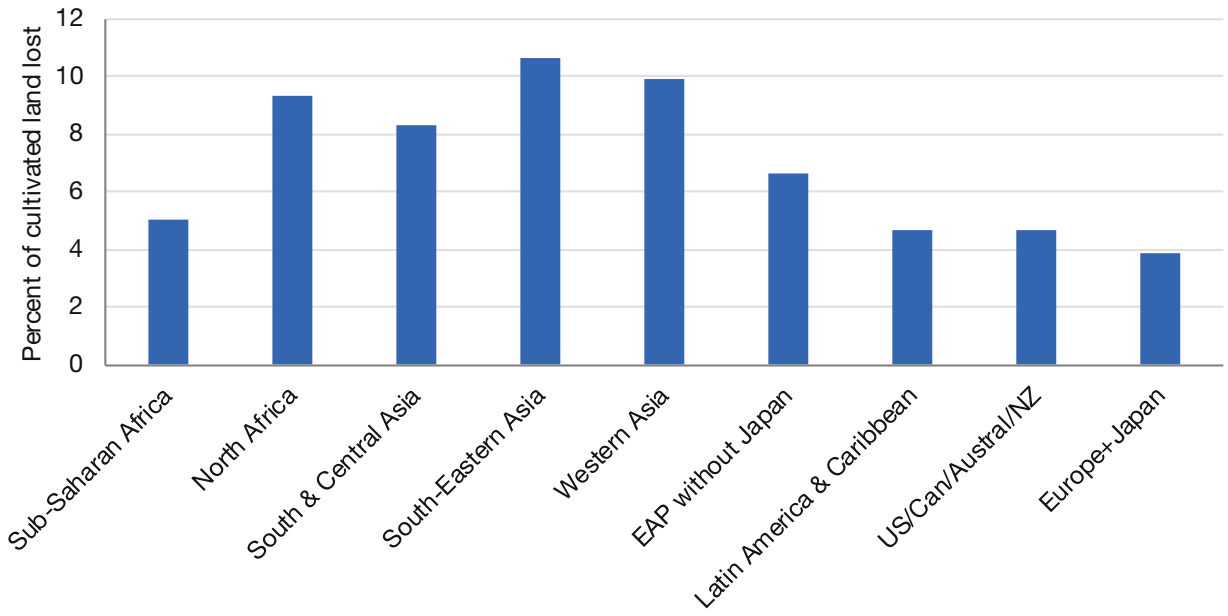
Guiding urban expansion to reduce the development of cultivated land is a clear priority, but how can it be accomplished? One way is to provide some key infrastructure facilities ahead of development located to help direct development away from cultivated land. Providing infrastructure ahead of development also costs about a third as much as retrofitting after development, so it is cost-effective. Moreover, some types of infrastructure—particularly arterial roads—are very difficult to build after development occurs because households and businesses would need to be displaced. Arterial roads also provide rights of way for trunk infrastructure, such as water and power, as well as routes for transit service. Implementation of this policy would need to be at the local or metropolitan level, not at the national level.

Recent analysis of satellite data provides information on the extent to which cities have been providing arterial road grids either historically or more recently. Angel and his colleagues have calculated for their global sample of 200 cities the percentage of urbanized area that has a system of arterial grids for two time periods: urbanized areas developed before 1990, and those developed from 1990 to 2014 (Angel, Lamson-Hall & et al., 2016). These data are available for 24 of the 25 African cities in the global random sample of cities and are shown in Figure 17.

The share of built-up area with gridded arterial roads is very low, the share is typically higher for areas developed before 1990, and planned arterial road grids are the exception for urbanized areas developed post-1990. For example, 15 of the 24 cities in the sample have no arterial grids in their areas developed since 1990. The lack of arterial road grids makes transportation within cities difficult, impedes the efficient operation of urban labor markets by increasing the costs of commuting, and hinders the installation of other trunk infrastructure—thereby increasing the cost of water, electric power, and other networked utilities. Remedying this situation for future urban development must be a priority in order to increase the productivity of African cities while directing urban development away from cultivated land.

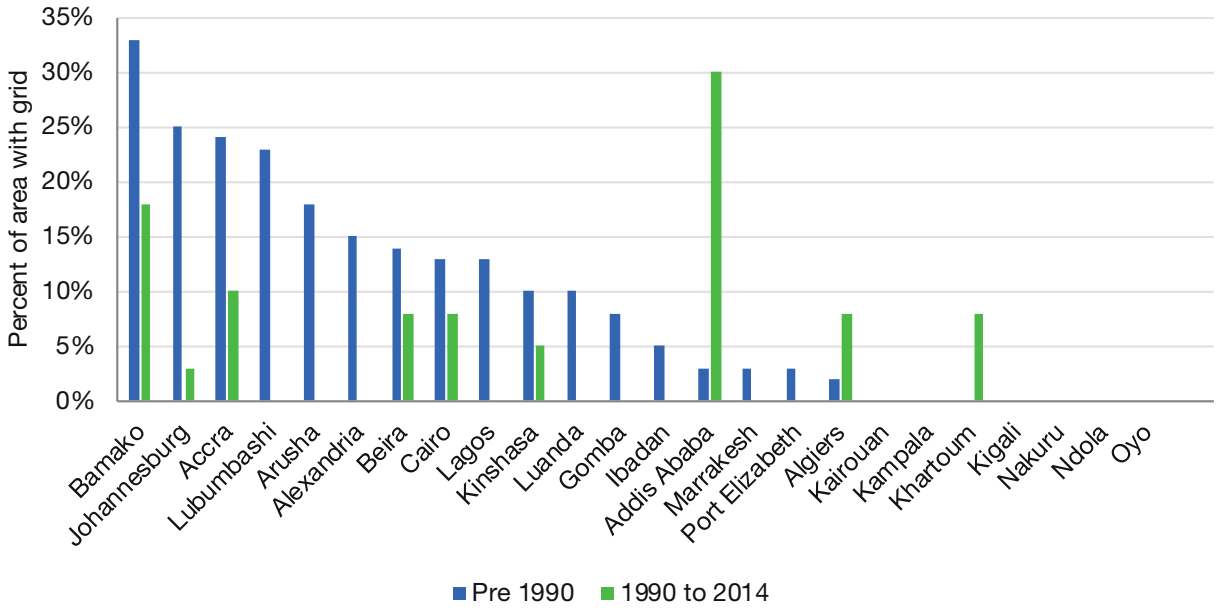
Given the dramatic expansion of African urban areas that will accompany the growth of urban populations, capacity must be developed to implement metropolitan-wide planning to accommodate the expansion if rapidly growing urban areas are to avoid being overwhelmed by informal settlements.

Figure 16: Percent of cultivated land lost with 2 percent annual urban density decline, 2000 to 2050



Source: Angel (2012), based on Figure 16.12, p. 281

Figure 17: Past and recent share of built up area with arterial grid



Source: Angel et al. (2016)

Getting ahead of development with designated rights of way and the installation of infrastructure before development raises questions about how low income households will pay for these facilities.

Planning urban infrastructure

Thus far, the terms cities and urban areas have been used interchangeably. Except for those in South Africa, the reality is that large metropolitan areas are typically composed of many municipal jurisdictions—with a main central city municipality surrounded by smaller urban centers and suburbs with their own municipal status. Moreover, planning and land use decisions are often made at the municipal or city level with little metropolitan-wide coordination. Given the dramatic expansion of African urban areas that will accompany the growth of urban populations, capacity must be developed to implement metropolitan-wide planning to accommodate the expansion if rapidly growing urban areas are to avoid being overwhelmed by informal settlements. Such an initiative preparing in advance for urban growth is underway in four cities in Ethiopia (Lamson-Hall, et al., 2015)

Planning will involve: (a) identifying urban expansion areas that minimally subsume cultivated land, (b) reserving rights of way for an arterial grid of roads, and (c) coordinating infrastructure investments across transport, water and sanitation, electric power, and telecommunications. Integrating plans across these infrastructure sectors must be done at the metropolitan level to take advantage of economies of scale and incorporate related network effects. Installing metropolitan-wide governments to accomplish the needed coordination is likely to be a political non-starter in many countries, so metropolitan-wide commissions or councils of government will need to be given oversight of metropolitan-wide planning. Development activities that do not involve large-scale systems effects or inter-jurisdictional spillovers can continue to be handled at the city or municipal level.

Development regulations also influence how urban areas grow. In many countries, the least-cost dwelling that meets existing standards for formal housing (relating to lot size, building materials, and size) is unaffordable to low income households. As a result, low income households construct dwellings in informal settlements that are below minimum formal standards, often in areas that are poorly served by transport, ecologically fragile, or distant from existing infrastructure services. Over time, informal dwellings are improved through progressive construction, and services and regularization are eventually provided, often years after the community is developed and at high cost. Standards should be consistent with affordability and not provide an incentive for informal development.

Getting ahead of development with designated rights of way and the installation of infrastructure before development raises questions about how low income households will pay for these facilities. One approach is that households should pay for private goods and the community should pay for public goods. For example, the cost of arterial rights of way and trunk infrastructure should be paid for by all beneficiaries at the city or metropolitan level, and households would bear the cost of service provided at the lot level. Because low income households often have irregular incomes and often expand their dwellings by progressive construction—spreading out costs over time—a similar extended payment scheme could be used for infrastructure installation at the lot level.

Estimates of national infrastructure investment and maintenance expenses are presented in a companion paper (Bond 2017), but how much of national investment is needed for cities? Direct estimates of infrastructure and maintenance expense for individual cities are virtually nonexistent in part because little information is available about infrastructure stocks (e.g., length of paved roads) or infrastructure investment (e.g., annual expenditure on paved roads) at the city or metropolitan level. However, indirect estimates of city level investment needs can be made.

Analysis indicates that a country's quantity of physical infrastructure stocks has little relation to its urbanization level but is strongly related to GDP (Ingram, Liu, and Brandt, 2013). The lack of a relation between urbanization and infrastructure seems surprising, but infrastructure costs per person vary inversely with population density (making infrastructure provision in cities less costly per

The share of national infrastructure investment and maintenance needed to support the growth of cities can be set proportional to cities' shares of national GDP.

capita), and much infrastructure located in rural areas (roads, power lines) serves urban residents. Accordingly, the share of national infrastructure investment and maintenance needed to support the growth of cities can be set proportional to cities' shares of national GDP. For example, if cities produce 60 percent of a country's GDP, a rough estimate of required funds for annual infrastructure investment and maintenance in that country's cities would be 60 percent of its estimated national infrastructure investment needs. Thus, if national infrastructure investment needs were 5 percent of such a country's national GDP, urban investment needs would be 3 percent of its national GDP.

Financing infrastructure investment and raising local revenue

When urban infrastructure is long-lived, it is equitable to spread its cost over time and to have future beneficiaries pay their fair share. This can be accomplished by partially funding it from longer term public or private debt or from international aid and other transfers. Several options exist for local borrowing. In some middle-income countries, municipal development funds have helped to develop both local government loan facilities and local urban government capacity to access loan financing, often with reliance on external aid (Kharas and Linn 2013). Some middle-income countries, including South Africa, now have municipal bonds (Martell and Guess 2006), and some municipal bonds have been sold directly on international markets.

Municipal bonds pose risks for both issuing governments and investors. Some risks of general obligation bonds can be lowered by issuing bonds in local currency, by utilizing third party guarantees or insurance, and by establishing a national fiscal responsibility framework specifying prudential conditions, such as maximum debt service ratios or the use of credit rating agencies. The risks associated with bonds used to finance privately operated projects can be reduced by (a) requiring that the project operator is legally separated from the local government, (b) assuring that tariffs will be adjusted to maintain a minimum debt service ratio, (c) including a clause to prohibit the government from building directly competing investments, and (d) including performance standards allowing the government to replace management or call in the credit if standards are not met (Ingram, Liu, and Brandt 2013).

Official development assistance (ODA) and lending from the International Bank for Reconstruction and Development (IBRD) and International Development Association (IDA) can be an important source of infrastructure investment funds in developing countries. ODA and World Bank (IBRD plus IDA) commitments for infrastructure in the past few years have each been in the range of $20 billion per year. Private investment in infrastructure has been a growing source of infrastructure finance over the past 25 years, and it has, for example, played a very important role in the remarkable expansion of mobile telephone service in Africa. Private participation in infrastructure (PPI) commitments have been four to six times larger than combined ODA and World Bank funding for infrastructure since 2006 and are now a major element of infrastructure finance, peaking at $195 billion in 2012. PPI and development assistance to infrastructure in 2012 together were about 40 percent of the total new infrastructure investment estimates for all developing countries (Ingram 2016), and are poised to play a key role in financing the infrastructure investment needs of rapidly growing cities in the coming decades. Past experience with PPI has provided some useful guidelines to promote success (see Box 1).

Public finance principles hold that each level of government should have enough budgetary autonomy to fulfill its expenditure responsibilities (Musgrave 1959), and metropolitan infrastructure investment will require local funds to cover investment directly or to repay debt. Lack of local revenue sources is a major issue in African metropolitan areas and municipalities (and in most developing countries). In addition, local tax systems often perform poorly.

In many countries, central governments have had little enthusiasm for transferring taxing authority to local governments. In some cases, central governments may be

Taxing local citizens to fund local services gives them a real incentive to engage with and oversee local services.

Box 1: Lessons of experience for successful Private Participation in Infrastructure (PPI)

The considerable experience of municipal and metropolitan areas with PPI projects over the last 30 years has yielded a number of insights about the potential impediments encountered and good practices developed:

- PPI projects are more successful when carried out under a well-specified national program or policy, often using model concession documents, rather than in an opportunistic way.
- Municipal governments often lack the institutional capacity to negotiate PPI agreements and so benefit from assistance from multilateral development banks or from a national public-private partnership unit that helps to facilitate and manage infrastructure investments.
- Legal constraints, such as national prohibitions on the use of arbitration for contract disputes between the government and private firms, may need to be addressed.
- A lack of bankable projects and a generally poor business climate is a frequent impediment in the lowest-income countries.
- Decentralization of revenue and investment responsibilities, which replaces a central national agency with many local agencies, can complicate PPI because local municipalities often lack the technical expertise to implement projects; a lack of coordination among neighboring municipalities may also lead to policy incoherence between municipalities, particularly for water supply and sanitation.

PPI has been concentrated in three sectors: telecom, energy, and transport. Two African countries, Nigeria and South Africa, were among the top ten recipients of PPI from 2001 through 2008.

Source: Ingram, Liu, & Brandt (2013)

able to raise revenues more efficiently (with lower collection costs) than local governments. However, political considerations can also be relevant. Local governments that are independent of central and provincial governments can become potential rival centers of political power, particularly when municipal and city officials are locally elected. By centralizing revenue collection and the funding of local governments through intergovernmental transfers, local governments become an extension of higher levels of government, and local accountability is reduced. However, taxing local citizens to fund local services gives them a real incentive to engage with and oversee local services.

User fees and benefit charges are attractive local sources of revenue that create appropriate incentives for both suppliers and users of services. User fees are most easily implemented in transport and public utilities having a fee-for-service regime, but the fees must be set at an appropriate level. Fees that are below costs promote overuse of services—a serious problem in electric power and water where subsidized rates undermine end-user efficiency by stimulating demand for services—and hence for more investment. In Africa, only one in ten water companies' tariffs cover full costs, though over half cover operating costs (Banerjee, et al. 2010). Low fees also create the need for subsidies. Recent estimates are that Sub-Saharan Africa governments spent $4.1 billion annually (0.7 percent of GDP) on power and water subsidies (Foster and Briceno-Garmendia 2010). While subsidies are often defended on social welfare grounds, their beneficiaries are predominantly the non-poor who have access to regular services while the poor are left with higher-cost, non-regular suppliers. Applying user fees and setting them at levels that cover costs is a goal that metropolitan and municipal governments should move toward.

As a local revenue source, the property tax is inherently attractive because real estate benefits from local services

Forecasts of the effects of climate change for Africa raise many concerns for both rural and urban areas. Projected effects include increases in average temperatures across the continent, less rainfall in northern and southwestern areas, and increasingly stressed water systems everywhere.

and is immovable, making the tax difficult to evade. It is used in many African municipalities and has been adapted in various ways to local conditions (Franzsen and Youngman, 2009). However, local property tax systems often have low tax rates, low yields, and many exemptions. Because the property tax is an appropriate local tax and already exists in many metropolitan and municipal areas in Africa, its performance should be improved. Moreover, its scope can be extended to include value capture, which taxes some of the increased land value associated with new infrastructure investments. Technological improvements, such as mass appraisal (using statistical techniques) and computer based mapping (using satellite images), are reducing property tax's administrative costs (McCluskey and Franzsen, 2013). Some countries are experimenting with simpler area-based systems that levy the tax on land area, built area, or per parcel rather than on an estimated market value.

Addressing climate change

Forecasts of the effects of climate change for Africa raise many concerns for both rural and urban areas. Projected effects include increases in average temperatures across the continent, less rainfall in northern and southwestern areas, and increasingly stressed water systems everywhere. These changes are forecast to lead to more extreme meteorological events including heavy rainfall, intense heat events, and more severe arid intervals. Such changes are likely to have a negative impact on the extensive rainfed agriculture that supports a large proportion of the population and to reduce crop yields (IPCC, 2014a).

If agricultural livelihoods become more precarious, migration flows from rural to urban areas may grow, particularly to cities whose economies are based on activities other than agricultural services. Some analysts argue that climate change may already have increased the rate of urbanization in Africa (Henderson, et al., 2016). In urban areas, climate change may intensify the severity of threats to human health because climate change acts as a multiplier of existing health vulnerabilities. This multiplier effect manifests itself through inadequate access to safe water and improved sanitation, limited access to health care and education, and food insecurity (IPCC, WGII, 2014b).

Populations in urban areas residing on low lying coastal areas and river flood plains are likely to be increasingly vulnerable to displacement from flooding caused by strong storms and from sea level rise. Inadequate urban infrastructure combined with heavy rain events will particularly affect poor and vulnerable populations (Gore 2015). These projections of more severe weather events imply a continuation of trends since 1960 that show a dramatic increase in flood events in Africa (Figure 18). Populations in low lying coastal areas are vulnerable to sea level rise that could be as much as a meter by 2100. In Africa, about 12 percent of the urban population and 7 percent of the total population live in coastal areas less than ten meters above sea level. These percentages are similar to global shares: 13 percent of the world's urban population and 10 percent of its total population are similarly situated (McGranahan, 2007). These are very large populations in low-lying coastal areas that are likely to be affected by storm surges and sea level rise.

Africa is highly vulnerable to climate change and faces many challenges in adapting to this threat. Local government capacity is often weak both in raising its own financial resources and in governance. Regulatory capacity and planning are often weak, data are fragmentary, infrastructure (particularly waste management and drainage) are inadequate, and residential settlements often have been established in fragile or vulnerable areas, such as floodplains, wetlands, and coastal zones. While local governments have been addressing climate change issues, most adaptations remain autonomous and reactive to short-term problems, and local adaptive capacity is typically low. Increasing adaptive capacity to climate change is very important; experience-based suggestions are noted in Box 2.

Populations in low lying coastal areas are vulnerable to sea level rise that could be as much as a meter by 2100. In Africa, about 12 percent of the urban population and 7 percent of the total population live in coastal areas less than ten meters above sea level.

Box 2: Lessons on adaptation drawn from African experience

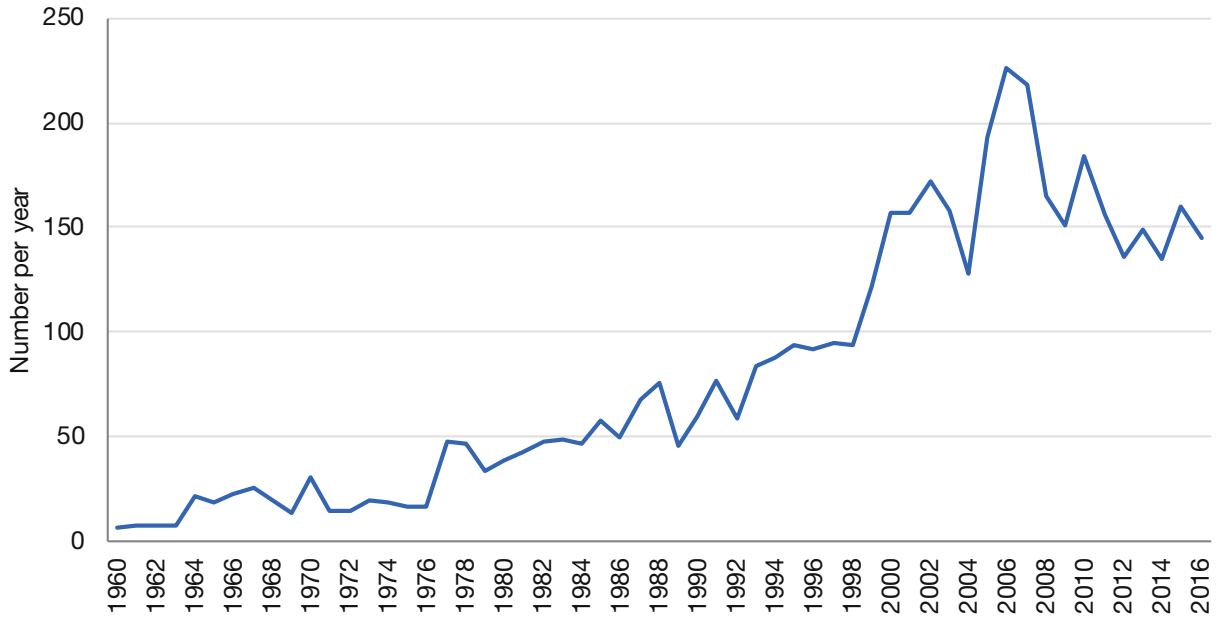
Five common principles for adaptation and building adaptive capacity have been distilled from a review of Africa's experience to date. Improving adaptation will require:

- supporting autonomous adaptation through a policy that recognizes the multiple-stressor nature of vulnerable livelihoods;
- increasing attention to the cultural, ethical, and rights considerations of adaptation by increasing the participation of women, youth, and poor and vulnerable people in adaptation policy and implementation;
- combining "soft path" options and flexible and iterative learning approaches with technological and infrastructural approaches and blending scientific, local, and indigenous knowledge when developing adaptation strategies;
- focusing on building resilience and implementing low-regrets adaptation with development synergies, in the face of future climate and socioeconomic uncertainties; and
- building adaptive management and social and institutional learning into adaptation processes at all levels. (22.4) IPCC WGII.

The assessment of significant residual impacts in a 2°C world at the end of the 21st century suggests that, even under high levels of adaptation, there could be very high levels of risk for Africa.

Source: IPCC (2014)

Figure 18: Floods per year in Africa



Source: EM-DAT (2016)

New technology as embodied in the concept of the smart city may have the potential to address many of the problems faced by African cities that are related to rapid population growth and the need to adapt to climate change.

Adapting to climate change and investing in infrastructure each place huge burdens on African economies, and the concomitant need to improve governance and government capacity is also daunting. African cities typically have better services than rural areas (e.g., water, sanitation, education, and health), and these contribute to producing urban life expectancies that are above national averages (Satterthwaite, et al. 2009). However, urban infrastructure is often poorly maintained and basic infrastructure services are not keeping up with urban growth, resulting in a decline in coverage relative to 1990 levels in many cities, especially for piped water (Banerjee, et al. 2007). Adapting existing infrastructure to climate change and adding facilities to reduce flood risks compounds the task. The challenge is to promote urban economic growth and to devote a sufficient share of that growth to investments in infrastructure and in metropolitan-area public goods so that infrastructure coverage can increase and events associated with climate change become less life-threatening and costly to urban residents.

New technologies and smart cities

New technology as embodied in the concept of the smart city may have the potential to address many of the problems faced by African cities that are related to rapid population growth and the need to adapt to climate change. The hope is that the relative lack of infrastructure and facilities will be an asset, allowing African cities to leapfrog directly to new technologies without being hampered by a legacy stock of aging and obsolete facilities. Underpinning this hope is Africa's experience with mobile telephone technology that has grown rapidly, allowing the telecommunications sector essentially to bypass investments in costlier fixed-line telephone service.

Smart city technology normally involves integrating information technology—especially digital technology—into the expansion, management, and operation of the city and its infrastructure. It involves collecting and using data to make infrastructure and urban systems more intelligent and efficient. The results are manifested in three ways. First, the integration improves the operating efficiency of existing systems so they produce more output per unit of input. This could be more vehicles per hour down a highway lane, less leakage or loss of water or power in distribution systems, higher completion rates of phone calls, lowered peak loads on power grids, or lower costs of toll collection or meter readings. Second, the integration may transform existing systems. For example, it could enable the generation of electric power to be distributed widely using solar panels rather than concentrated in large generating stations, or sanitary waste to be processed by composting rather than using water intensive methods. Third, the changes could be unexpected or difficult to predict. For example, the internet-of-things could automatize food shopping based on continually updated records of household inventories. These three types of results could improve efficiency and/or performance of urban systems by saving capital or operating costs in African cities.

Of course, this technology is not without its own risks and drawbacks. Most immediate is the loss of privacy that accompanies the collection of data about individuals, whether it is driving habits, records of purchases, or detailed data on telephone calls. In addition, the aggregation and use of digital data often is subject to scale economies and network effects, so that average data analysis costs fall as the quantity of data to be analyzed increases. These effects are likely to lead to the data being analyzed by one or a few large firms that would not be subject to the discipline of competitive markets, so prices could become high for these services. Finally, these systems might be subject to hacking or systemic failure. Actual experience with recent failures of computerized municipal traffic light systems or air traffic control systems indicate how disabling such breakdowns could be.

African cities do have other advantages, besides an absence of legacy facilities, that may facilitate the adoption of new urban technologies. The high rate of urban population growth and the looming problems of climate

Many African municipalities are engaged in smart city projects to improve the quality of life of their citizens, enhance the experience of businesses, and provide an environment that is conducive to economic development.

change create great pressure to improve service delivery, to promote economic diversification and growth, to seek solutions with lower capital costs, and to increase operational efficiency. In addition, the demographic composition of the population, with many young adults, may facilitate the adoption of new and technologically intense solutions. The high penetration of mobile phones in African countries and the local development of innovations, such as mobile-based payments, provide the basis for optimism about the adoption of new technologies.

Although smart city approaches may seem to have modest relevance in less developed countries, many developing countries are surprisingly engaged with intelligent urban systems. Several countries have been constructing new green cities as platforms for smart technology. These efforts include Songdo in Korea, the Tianjin eco-city in China, Masdar in the United Arab Emirates, and Konza Techno City in Kenya. Many African municipalities are engaged in smart city projects to improve the quality of life of their citizens, enhance the experience of businesses, and provide an environment that is conducive to economic development (Walker 2016). Some examples of the many projects that involve smart city technology and techniques are summarized in Box 3.

Although smart city approaches are likely still in their infancy, a review of experience that cities have had so far provides some insights. First, cities that have mainly responded to proposals from private vendors in an ad hoc fashion have not done as well as cities that have first developed a technology vision or plan that emphasizes productivity and connectivity. Second, allowing open access to data and broadband along with collaboration with citizens and technologists has fostered inclusiveness and support from citizens for new technologies. Demonstration projects focused on a neighborhood or specific problem have helped identify issues before applications are scaled up to the city or metropolitan level. New projects that seem not to involve smart technology should be vetted to ensure their future potential compatibility in order to avoid costly retrofitting later. Finally, establishing and using a public-private support and advisory group of knowledgeable persons can aid in educating citizens about the potential of smart city technology (Puentes and Tomer 2014)

Box 3: Smart city innovations in Africa

Many projects in Africa embody smart city approaches; here is a sampling:

- **Data collection for social change**: The Ushahidi project, initially developed by Juliana Rotich and her team to map reports of violence in Kenya after the post-election violence in 2008, expanded across the world and is now one of the most-used platforms of its kind.
- **Mobility and traffic congestion**: Twende Twende (Swahili for "let's go") is a mobile phone service developed in IBM's research center in Nairobi that takes images captured by existing low-cost cameras and applies network-flow algorithms to estimate traffic flow. The solution does not require road construction but provides information that helps facilitate traffic flows.
- **Innovation anywhere**: The iHub project in Nairobi, Kenya, is an open community space—part vector for investors and venture capital funders, part incubator—providing a space where young entrepreneurs can receive mentorship, Internet connectivity, and the possibility of funding through connections with the international venture capital community.
- **Ethical energy**: The iShack Project, a social enterprise, provides a pay-for-use solar electricity service to people living in slums of the South African city of Stellenbosch.

Source: Ratti (2016)

Urban expansion's potential conversion of cultivated land is particularly large for North Africa but also of concern for Sub-Saharan Africa.

The decision to implement smart city approaches in a top-down or bottom-up fashion is related to the decision about open versus closed access to data and approaches. Top-down approaches typically employ a single large vendor who is responsible for data gathering (and installing associated sensors), data analysis, central control, and management. Such top-down single vendor approaches often use closed access proprietary systems with the vendor having control of the data and its analysis. The opposite approach is an open data operation—usually web-oriented—that enables individuals and firms to develop software solutions independently. Several smart phone applications have been developed in this fashion for transit agencies to provide customers with access to current transit system data on service schedules.

Many observers have a preference for bottom-up decentralized systems because such an approach produces more innovation and lowers smart technology costs (Townsend 2013). In fact, cities and metropolitan areas may use a top-down approach for some systems where engineering efficiency is paramount and a bottom-up approach where consumer service is more critical. Cities need to recognize the existence of the two alternative approaches and to consider their benefits and costs when choosing technologies because it may be costly to shift from one technological path to another.

Conclusion

Sub-Saharan Africa is the poorest global region (containing 25 of the 30 countries ranked as low income by the World Bank in 2014), and the region is projected to have the largest absolute (1.3 billion) and percentage (150 percent) increase in total population across nine global regions from 2010 to 2050. North Africa's population growth is the second largest in percentage terms with a projected increase of 60 percent.

A potential benefit for Sub-Saharan Africa from its strong population growth could come from its continuously falling dependency ratio, potentially creating a demographic dividend that will enhance economic growth. North Africa shows a modest decline followed by a modest increase in dependency over this period. However, demographic change can create social challenges if economic growth is inadequate to provide jobs and incomes for the growing population—particularly for young adults aged 15 through 29. Sub-Saharan Africa's projected percent of population aged 15 through 29 is consistently high (and the highest among global regions from 2015 on). For North Africa, this age group's share is the second highest from 2030 on. The demographic dividend that Sub-Saharan Africa will experience is good demographic news, but the high population share of young adults could create problems if economic growth is low and unemployment is high. This is an ongoing concern because recent increases in urbanization in many African countries have not been accompanied by the structural transformations in national or urban economies that have accompanied urbanization in other regions. While national and municipal policies can influence economic growth, they are unlikely to have much impact on demographic trends in the short and medium run.

Sub-Saharan Africa is projected to experience the largest absolute increase in urban population across the regions, but even more remarkable are the percentage increases: Sub-Saharan Africa's urban population is projected to quadruple and North Africa's to double. The large increase in urban population projected for Sub-Saharan Africa is driven mainly by its large projected total population increase; because its urban population share is projected to progress in a very regular manner.

Urban population growth will increase urbanized land areas. If urban population densities continue to decline following historic trends, urbanized land areas in Sub-Saharan Africa and North Africa will grow to be 7.5 and 4.5 times their size in 2000. Urban expansion's potential conversion of cultivated land is particularly large for North Africa but also of concern for Sub-Saharan Africa. Guiding urban expansion to minimize building on cultivated land is a clear priority, and this can be aided by installing a

Experience to date indicates that cities that have a technology vision or plan for smart city technologies do better than cities that merely respond to vendor proposals.

one kilometer grid of arterial roads prior to development. Investing in infrastructure ahead of urban expansion is also critical because retrofitting urban infrastructure in developed areas is three times as costly as installing urban infrastructure before development. Analysis of a random sample of African cities reveals that only small shares of their urbanized areas have road grids, and a majority of African cities do not have any arterial road grids in areas urbanized since 1990.

Given the dramatic expansion of African urban areas that will accompany the growth of urban populations, capacity must be developed to plan for such growth at the metropolitan-wide level, likely through a metropolitan commission; planning at the municipal level cannot take account of economies of scale and network effects that pervade urban infrastructure. The costs of infrastructure investment are difficult to calculate at the city level, but existing analysis suggests that the urban share of national infrastructure costs would be proportional to the urban share of national GDP. Because much infrastructure is long-lasting, spreading its cost over time by using debt financing is sensible. Several middle-income countries have begun to issue municipal bonds, and development assistance in the form of grants and loans can help fund infrastructure. Private participation in infrastructure has grown dramatically, and its annual total has recently been five times larger than development assistance. It has played a key role in the expansion of mobile phone systems in Africa.

Setting the tariffs for infrastructure services appropriately is important both to cover the costs of supply and to promote end-user efficiency by preventing over consumption. Recent estimates are that Sub-Saharan Africa governments spent $4.1 billion annually (0.7 percent of GDP) on power and water subsidies. Funding urban infrastructure will require larger expenditures at the municipal level, and in Africa municipal governments have few sources of local revenue. This needs to change. The property tax is widely used but relatively ineffective in African cities. It is well suited as a revenue source to fund infrastructure, and recent technological advances, such as satellite imagery, can reduce collection costs.

Africa is highly vulnerable to climate change and faces many challenges in adapting to its threats. Key issues are overall increased stress on water systems, more numerous extreme meteorological events, and the threat of coastal flooding potentially affecting the 12 percent of Africa's urban residents who live in low-lying coastal areas. Inadequate urban infrastructure combined with heavy rain events will particularly affect poor and vulnerable populations.

Local governments have been addressing climate change issues, but most adaptations remain autonomous and reactive to short-term problems and local adaptive capacity is typically low. Increasing adaptive capacity to climate change is very important. The challenge is to promote urban economic growth and to devote a sufficient share of that growth to investments in infrastructure and in metropolitan-area public goods so that infrastructure coverage rates can increase and climate change events become less life-threatening and costly to urban residents.

New technology embodied in smart city approaches has real promise in Africa, and many local initiatives are underway. One model for smart city technology's appeal in Africa builds on African experience with mobile phones—where the new mobile technology leapfrogged over the old, and Africa essentially bypassed costly land-line systems. The hope is that Africa's lack of infrastructure and facilities will become an asset, as there would be little burden from legacy systems as new technologies emerge.

Experience to date indicates that cities that have a technology vision or plan for smart city technologies do better than cities that merely respond to vendor proposals. Choices need to be made between top-down and bottom-up technological approaches, and these choices are often related to decisions between systems that are open and closed in terms of access to data and its analysis. Smart city technology also poses challenges for personal privacy (data often can track individual behavior) and for

Within a supportive national framework, the success of cities and metropolitan areas will be determined to a great extent by policies pursued at the metropolitan and municipal level—including planning for urban expansion and provision of basic infrastructure services.

the robustness of the systems (they must be reliable and resist hacking).

To handle successfully the forecast large increases in total and urban populations and the unprecedented expansion of urbanized areas over the next 40 years, African countries must pursue national policies that promote economic growth, health care, and education within a supportive macroeconomic and regulatory framework. Within a supportive national framework, the success of cities and metropolitan areas will be determined to a great extent by policies pursued at the metropolitan and municipal level—including planning for urban expansion and provision of basic infrastructure services. Sound national policies are necessary but not sufficient for success at the metropolitan level. Within a supportive national policy, metropolitan areas can underperform by pursuing poor policies. But with poor national policies, even excellent policies at the metropolitan level are unlikely to succeed. National governments and metropolitan areas need to work together to manage an effective transition to an urbanized African society.

Annex 1: Classification of countries into nine groups

This classification, as referenced in Chpater 3. “Demographics and urbanization,” is a variation on the country groups used in *World Population Prospects: The 2012 Revision* produced by the UN Department of Economic and Social Affairs Population Division.

Sub-Saharan Africa

Angola
Benin
Botswana
Burkina Faso
Burundi
Cameroon
Cape Verde
Central African Republic
Chad
Comoros
Congo
Côte d’Ivoire
Democratic Republic of the Congo
Djibouti
Equatorial Guinea
Eritrea
Ethiopia
Gabon
Gambia
Ghana
Guinea
Guinea-Bissau
Kenya
Lesotho
Liberia
Madagascar
Malawi
Mali
Mauritania
Mauritius
Mayotte
Mozambique
Namibia
Niger
Nigeria
Réunion
Rwanda
Saint Helena
São Tomé and Príncipe
Senegal
Seychelles
Sierra Leone
Somalia
South Africa
South Sudan
Sudan
Swaziland
Togo
Uganda
United Republic of Tanzania
Western Sahara
Zambia
Zimbabwe

Northern Africa

Algeria
Egypt
Libyan Arab Jamahiriya
Morocco
Tunisia

East Asia and Pacific excluding Japan

East Asia

China
China, Hong Kong SAR
China, Macao SAR
Democratic People’s Republic of Korea
Mongolia
Republic of Korea

Pacific

American Samoa
Cook Islands
Fiji
French Polynesia
Guam
Kiribati
Marshall Islands
Micronesia
Nauru
New Caledonia
Niue
Northern Mariana Islands
Palau
Papua New Guinea
Samoa
Solomon Islands
Tokelau
Tonga
Tuvalu
Vanuatu
Wallis and Futuna Islands

South-Central Asia

Kazakhstan
Kyrgyzstan
Tajikistan
Turkmenistan
Uzbekistan
Afghanistan
Bangladesh
Bhutan
India
Iran (Islamic Republic of)
Maldives
Nepal
Pakistan
Sri Lanka

South-Eastern Asia

Brunei Darussalam
Cambodia
Indonesia
Lao People's Democratic Republic
Malaysia
Myanmar
Philippines
Singapore
Thailand
Timor-Leste
Viet Nam

Western Asia

Armenia
Azerbaijan
Bahrain
Cyprus
Georgia
Iraq
Israel
Jordan
Kuwait
Lebanon
Oman
Qatar
Saudi Arabia
State of Palestine
Syrian Arab Republic
Turkey
United Arab Emirates
Yemen

Europe plus Japan

Albania
Andorra
Austria
Belarus
Belgium
Bosnia and Herzegovina
Bulgaria
Channel Islands
Croatia
Czech Republic
Denmark
Estonia
Faeroe Islands
Finland
France
Germany
Gibraltar*
Greece
Holy See
Hungary
Iceland
Ireland
Ireland
Isle of Man
Italy
Japan
Latvia
Liechtenstein
Lithuania
Luxembourg
Malta
Monaco
Montenegro
Netherlands
Norway
Poland
Portugal
Republic of Macedonia
Republic of Moldova
Romania
Russian Federation
San Marino
Serbia
Slovakia
Slovenia
Spain
Sweden
Switzerland
Ukraine
United Kingdom

Latin America and the Carribean

Anguilla
Antigua and Barbuda
Argentina
Aruba
Bahamas
Barbados
Belize
Bolivia
Brazil
British Virgin Islands
Caribbean Netherlands
Cayman Islands
Chile
Colombia
Costa Rica
Cuba
Curaçao
Dominica
Dominican Republic
Ecuador
El Salvador
Falkland Islands
French Guiana
Grenada
Guadeloupe
Guatemala
Guyana
Haiti
Honduras
Jamaica
Mexico
Nicaragua
Panama
Paraguay
Peru
Suriname
Uruguay
Venezuela

Land rich industrial countries

Australia
Canada
New Zealand
United States of America

Annex 2: Random sample of 25 African cities

Table A1: Random sample of 25 African cities

City	Country	2014 Population
Accra	Ghana	4,429,649
Addis Ababa	Ethiopia	3,009,130
Alexandria	Egypt	4,345,193
Algiers	Algeria	3,085,560
Arusha	Tanzania	377,169
Bamako	Mali	2,358,106
Beira	Mozambique	382,574
Cairo	Egypt	15,734,934
Gomba	Nigeria	416,874
Ibadan	Nigeria	2,954,967
Johannesburg	So. Africa	8,000,158
Kairouan	Tunisia	127,569
Kampala	Uganda	3,017,000
Khartoum	Sudan	5,061,792
Kigali	Rwanda	821,881
Kinshasa	Congo Dem.Rep.	10,226,182
Lagos	Nigeria	11,008,356
Luanda	Angola	5,555,024
Lubumbashi	Congo Dem.Rep.	1,746,414
Marrakesh	Morocco	770,422
Nakuru	Kenya	326,159
Ndola	Zambia	443,326
Oyo	Nigeria	452,476
Port Elizabeth	South Africa	952,746
Tebessa	Algeria	203,542

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