



# Why Urban Ecology Matters in Ethiopia

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Three concurrent global environmental trends are particularly apparent: human population growth, urbanization, and climate change. Especially in countries such as Ethiopia in the Global South, all three are impacted by, and in turn have bearing upon, social justice and equity. Combined, these spatial and social factors reduce wellbeing, leading to increasing urgency to create urban environments that are more livable, resilient, and adaptive. However, the impacts on, and of, non-human urban residents, particularly on the ecosystem services they provide, are often neglected. We review the literature using the One Health theoretical framework and focusing on Ethiopia as a case-study. We argue for specific urban strategies that benefit humans and also have spillover effects that benefit other species, and vice versa. For example, urban trees provide shade, clean the air, help combat climate change, create more livable neighborhoods, and offer habitat for many species. Similarly, urban neighborhoods that attract wildlife have characteristics that also make them more desirable for humans, resulting in improved health outcomes, higher livability, and enhanced real-estate values. After summarizing the present state of knowledge about urban ecology, we emphasize components relevant to the developing world in general and pre- COVID-19 pandemic Ethiopia in particular, then expand the discussion to include social justice and equity concerns in the built environment. Prior to the ongoing civil war, Ethiopia was beginning to invest in more sustainable urbanization and serve as a model. Especially in light of the conflict and pandemic, much more will need to be done.

## OPEN ACCESS

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### Specialty section:

This article was submitted to  
Urban Ecology,  
a section of the journal  
Frontiers in Ecology and Evolution

**Received:** 26 December 2021

**Accepted:** 18 February 2022

**Published:** 15 March 2022

### Citation:

Perry G, Gebresenbet F, DaPra M, Branco P, Whibesilassie W, Jelacic M and Eyob AE (2022) Why Urban Ecology Matters in Ethiopia. *Front. Ecol. Evol.* 10:843698. doi: 10.3389/fevo.2022.843698

**Keywords:** urban ecology, Ethiopia, human population, global climate change, urbanization, social justice, One Health

## HIGHLIGHTS

- Urbanization, climate change, and population growth intersect and globally affect wellbeing of humans and other species.
- Urban strategies benefitting humans also sustain biodiversity, enhance ecosystem services, and reduce climate impacts.
- We review social justice and ecological equity in human-built environments, applying global insights to the realities of Ethiopia.
- Investment in wise urban, secondary city, and peri-urban development is recommended for Ethiopia's post-war, post COVID-19 recovery process.

## INTRODUCTION

Three major global challenges are presently concurrently receiving considerable attention: climate change, urbanization, and human population growth. Each affects many people, particularly in the Global South, as well as the natural environment. Often ignored in these contexts are social justice and equity considerations, yet climate change impacts, for example, disproportionately affect vulnerable groups. Human population growth, which is occurring unevenly across the globe, is further aggravating some inequality and social injustice trends, which in turn has ecological and evolutionary consequences (Schell et al., 2020). These processes affect not only human wellbeing but also global biodiversity and the ecosystem services it provides.

Urban planning that considers the many challenges to reaching resiliency and sustainability can and should help address the intersection of climate change, human population growth, and urbanization, for example by enhancing ecosystem services of social-ecological systems (Davids et al., 2021). Below we first review each component separately, then discuss how they interact. Throughout, we begin with global patterns, then provide an Ethiopia-specific perspective where available. We chose Ethiopia because it serves as an instructive example of the challenges and opportunities offered by many Global South nations. Our intention is not to propose solutions from the outside, but rather to provide analysis and stimulate local approaches that take into account local resources, values, and aspirations, in order to help strengthen endogenous forms of sustainability and resilience (Ziervogel et al., 2017). One approach often used in this context, though usually in a rural rather than urban context, is One Health, an attempt to jointly address the well-being of animals, humans, and the environment (Destoumieux-Garzón et al., 2018). This approach is increasingly being implemented in Ethiopia (Pieracci et al., 2016; Husein, 2020).

## REVIEW OF THE LITERATURE

### Human Population Growth

Today's global human population is about 1,860 times the size of what it was 12 millennia ago. It is projected to exceed 9 billion by 2045 (United Nations [UN], 2019), exerting unprecedented pressure on natural resources. Habitation and infrastructure growth have forced urban land to more than double between 1960 and 2007, to 2.8% of total land area (Hooke et al., 2012), and continues to accelerate. Over half of the urban infrastructure that will exist by the end of this decade has yet to be built (OECD, 2020). To meet the food needs of the growing population, agricultural lands (crops, arable land, and permanent pastures) have expanded to 38.6% of land area (Tilman et al., 2011; Alexandratos and Bruinsma, 2012; Hooke et al., 2012).

### Population Growth in Africa and Ethiopia

According to United Nations projections, there will be 2.2 billion humans in Africa by 2050, nearly a quarter of the global

population, with sub-Saharan Africa accounting for most of the increase (United Nations [UN], 2019). This demographic trend is the result of upturns in average life expectancy (from 42.3 to 66 years) and a lag in slowing birth rates, impeding the fight against poverty (United Nations [UN], 2019). With a 2019 population of approximately 112.7 million – up from a 2015 estimate of 98.9 million – Ethiopia is the second most populous country in sub-Saharan Africa, and one of the fastest growing (historically >3% per year) in the world (Central Statistical Agency of Ethiopia [CSA], 2013). Although the rate has been declining, it remains above 2.5%/year (summarized by the World Population Review<sup>1</sup>). Based on present growth rates, the population is expected to double over the next 30 years, hitting 210 million by 2060. Rapid population growth in Ethiopia has already resulted in land degradation, particularly noticeable in the northern highlands where adequate rainfall and fertile soil create high agricultural potential.

### Urbanization as a Global Phenomenon

One of the biggest changes in human life over that past few centuries has been the increase in the proportion of the population living in urban settings. A combination of “push” factors, which move people away from rural areas, and “pull” factors, primarily related to economics and quality of life, attract them to cities (e.g., Thet, 2014). This has been most apparent, and best acknowledged, in the Global North. In the United States, for example, some 90% of people lived in rural settings around 1800, while only about 20% do so today. Globally, about 35% of the population lived in cities in 1950. Today, that number is over 50% (reviewed in Perry et al., 2020). Strikingly, the number of urban dwellers increased from 220 million in 1900 to 2.84 billion in 2000 and is estimated to be over 6 billion by 2045 (Aneseyee, 2016; Perry et al., 2020). The median country passed the 50% mark in the past few years, and even the poorest countries are urbanizing at high rates (Perry et al., 2020). Unfortunately, with urbanization often comes increasing distancing of humans from nature (Turner et al., 2004).

### Urbanization in Africa and Ethiopia

The most rapid rates of urbanization now occur in the developing world and will continue to do so in the future (Zhang, 2016). In Ethiopia, over 80% of the population is rural and dependent on agriculture, mostly small-holder and family based (reviewed in Ayele and Tarekegn, 2020). Yet, urbanization rates in Ethiopia are some of the highest in the world (United Nations Department of Economic and Social Affairs [UNDESA], 2018). In 1960s, the urban population in Ethiopia was 6%, but it almost tripled by 2010 (Bekele and Hailemariam, 2010). By mid-century, over 40% of Ethiopians are expected to live in cities (United Nations [UN], 2019), roughly twice the present number. The growth in urban population, not just in Addis Ababa but also secondary cities such as Mekele in the north and Arba Minch in the south, is ongoing, rapid, and poorly regulated (Ayele and Tarekegn, 2020).

<sup>1</sup><https://worldpopulationreview.com/countries/ethiopia-population>

## Urbanization as Economic Adaptation

The contribution of cities to the global economy is disproportionate – as much as 80%, by some estimates (UN Human Settlements Program [UN-HABITAT], 2013). Rapid population growth, in conjunction with improving standards of living in many developing countries, provide an ever-growing pool of potential new urbanites, resulting in ongoing land-use change and associated alterations to biogeochemical cycles (e.g., Grimm et al., 2008). Urban areas generate more than 80% of global GDP and almost 70% of global CO<sub>2</sub> emissions (reviewed in Perry et al., 2021). Across nations, the process of urbanization appears to correlate with a gradual increase in economic activity until high levels of urbanization are reached, when very rapid economic activity occurs (Perry et al., 2021).

### Urbanization and Economic Adaptation in Ethiopia

As of 2019, the World Bank reports that Ethiopia's cities contained about 15% of the total workforce but contributed almost 40% of the nation's gross domestic product<sup>2</sup>. In response to rapid urbanization, the government of Ethiopia has begun the process of exploring ways to better manage urban expansion (Lamson-Hall et al., 2019), which is resulting in loss of agriculturally important lands (Ayele and Tarekegn, 2020). Recent work suggests that the ongoing development of parts of Addis Ababa is “targeting domestic elites, the Ethiopian diaspora and tourists,” that is, economic interests, rather than local stakeholders (Terrefe, 2020).

### Climate Change in Urban Settings

The third major thread in this review, and by far the best covered in both the popular media and the peer-reviewed literature, is global climate change (GCC), caused by human activities (IPCC, 2021a). GCC is estimated to contribute to an additional 100 million people being pushed into extreme poverty from 2016–2030, the majority of whom live in cities (Hallegatte et al., 2016). Overall heating and increases in extreme events such as droughts, floods, heat waves, cyclones and storms are some of the broadly apparent impacts. Economic impacts related to climate change are at the top of the list collated by Rapp and Leaf (2019). Also high on that list are events related to urbanization, such as water crises, biodiversity loss, and human migration. Because they are densely populated, are frequently located along coastlines, and because they were often not designed with climate resiliency in mind, urban centers tend to be more drastically impacted by such events (Thomas et al., 2019). Furthermore, the concentration of urban populations and infrastructure on coasts and by rivers, in arid areas and in fragile ecosystems, means increased exposure to extreme weather (Marcotullio, 2015). Cities are impacted by GCC, but also exacerbate it through removal of vegetation, high consumption of fossil fuels, and more (Grimm et al., 2008).

Urban areas are “heat islands” where built surfaces (asphalt roads, building roofs, pavements, etc.) aggravate the impact of anthropogenic climate change (Feyisa et al., 2014). In

evaluating likely impacts of GCC on urban environments, Maxwell et al. (2017) concluded that GCC can impact social inequality, aging and deteriorating infrastructure, and already stressed ecosystems, further worsening urban quality of life. Indeed, droughts are already resulting in drying up of essential water sources in places as diverse as Cape Town, South Africa, Chennai, India, and Mexico City, Mexico, and recent heat waves again broke temperature records and caused fatalities in Europe and elsewhere. At the other extreme, popular media has been reporting that cities in numerous parts of the world suffered from catastrophic flooding in 2020 and 2021.

### Global Climate Change in Ethiopia, Particularly Urban Settings

The major environmental issues affecting Ethiopia are soil erosion and land degradation, deforestation and forest degradation, water scarcity, rapid biodiversity loss, and pollution (Wassie, 2020). These environmental issues are, of course, closely interlinked with GCC and population growth and have joint impacts (e.g., Marie et al., 2020). Human development, provision of basic services, and poverty eradication will be also negatively impacted by rapid population growth and climate change (Braat and De Groot, 2012).

Several studies have produced projections of future climate change impacts on urban Ethiopia, and particularly the capital city Addis Ababa. Arsiso et al. (2017) predicted that the combination of population growth, urbanization, and climate change will result in severe water shortages in Addis Ababa and elsewhere within a few decades. Lake Abijatta, for example, is rapidly shrinking and highly susceptible to climate impacts (Oduor and Kotut, 2016), and the same is happening to the other lakes in the central part of the Great Rift Valley. At the same time, Addis Ababa is expected to face increasing instances of flooding (Birhanu et al., 2016). Heat-island effects and intra-city variability in rainfall will also grow (Arsiso et al., 2018). Nor are predicted impacts limited to that one city (Paul et al., 2016; Belay et al., 2017). For example, work from Jimma, well south of Addis Ababa and much smaller, shows significant changes in climate and growing public awareness of the trend (Gemedet al., 2021).

### Environmental Adaptation in Urban Settings

Conservation biologists have traditionally focused on habitats with limited human presence and on the species most endangered by human activities. Cities are, by definition, human-constructed places. Many of the species in them are not just common locally, but are globally distributed commensals often viewed with distaste, such as the common pigeon (*Columba livia*) or Norway rat (*Rattus norvegicus*) (Perry et al., 2020). Other species are highly intolerant of urban environments and nearly never encountered in human settings (Perry et al., 2020). Consequently, biologists have not customarily given much attention to the non-humans that share urban settings with us, compared to those in more natural settings. But a surprisingly large number are at least sometimes found in urban settings within their native range (Perry et al., 2008). Although some urban species can come into conflict with humans, many are not noticed by people and some

<sup>2</sup><https://blogs.worldbank.org/africacan/why-should-ethiopians-care-about-urbanization-jobs-infrastructure-and-formal-land-and-housing>, accessed 28 April 2020

may even be the cause of considerable excitement and delight, for a variety of cultural and other reasons (Perry et al., 2020). This is also true, though not well-researched, in Ethiopia. For example, spotted hyenas (*Crocuta crocuta*) are commonly seen on the outskirts and even inside Ethiopian towns (Abay et al., 2011; for recent work on urban ecology in the Global South see Shackleton et al., 2021). African civets (*Civettictis civetta*) are also seen close to villages and prey on poultry and food material thrown outside (Daniel et al., 2011). Urbanization can also ultimately impact nearby areas, allowing urban non-native species to spread outward in Ethiopia and elsewhere (e.g., Beyene et al., 2009; Pyšek et al., 2020).

## DISCUSSION

Global climate change impacts cities and the growing number of humans, as well as other species, living in them (Grimm et al., 2008; Perry et al., 2020), although in some African cases, biodiversity has been able to persist in urban spaces (e.g., McPherson et al., 2021). The number of people, the state of city infrastructure, and the identity and prevalence of other species, all affect human well-being and economic success, which suffer when social justice and equity is lacking. Above, we have predominantly discussed climate change, human population growth, urbanization and urban ecology, and social justice as though they are independent issues. However, the four have strong interdependencies, which we now turn to more explicitly.

### Urbanization, Human Population Growth, and Land Degradation

Growing human populations in urban settings are the result of overall human population growth and the continuing movement of individuals from rural to urban settings. The main drivers of this migration, which can be forced or voluntary, include seeking improved fulltime or seasonal economic gains and personal fulfillment, conflict-related shocks, GCC impacts, and stress from environmental degradation (Clement et al., 2021). Improved overall economics of urban populations increase demand for food and other products that cannot be produced in the city, encouraging outlying intensive agriculture characterized by mechanization and a growing reliance on artificial fertilizers and pesticides. This urban population growth can also have heavy negative environmental impacts (Green et al., 2005), including contributing to further GCC, increased land degradation, and urban heat island effects. We further discuss these in the next section, which focuses more on GCC. Moreover, the demands of cities for water and other supplies can and do conflict with the needs of outlying areas, and so have broader impacts beyond what will be discussed here (e.g., Flörke et al., 2018).

### Global Climate Change and Its Effects in Urban Settings

As standards of living go up, GCC-driven heat waves result in increased electrical demands and enhance the crumbling of urban infrastructure not designed for sustained high temperatures (Salimi and Al-Ghamdi, 2020). Adverse effects on health and

working productivity can also be substantial. In turn, GCC is expected to cause the migration of over 200 million people to urban centers by 2050, over 85 million of them in sub-Saharan Africa (Clement et al., 2021). The effects of climate change do not limit themselves to humans, of course, and indiscriminately impact other species found in the same spaces. City governments are increasingly aware of this, sometimes to a greater degree, or with a greater sense of urgency, than national leaderships. For example, a recent review of GCC adaptation in cities in India found that about half of 53 Indian cities with a population of > 1 million had reported plans for adaptation action, and some two thirds have begun implementation (Singh et al., 2021).

### An Ethiopian Perspective

Socioeconomic inequities mean that poorer countries and neighborhoods often experience particularly detrimental conditions as climate change impacts cities (reviewed in Harlan et al., 2015). GCC already affects vegetation in Ethiopia (Workie and Debella, 2018). For example, vegetative community deterioration as a result of human activities exacerbates climate change, creating a self-reinforcing positive feedback loop (Tadesse et al., 2017). In another impact, malaria distribution has expanded into new territories of the highlands of Ethiopia and Colombia in warmer years (Siraj et al., 2014). In a recent World Bank study on the impacts of GCC, several areas in Ethiopia, which served as a case study, and most notably the area around Addis Ababa, show significant population increase compared to a no-GCC scenario (Clement et al., 2021).

### Urban Social Justice

Environmental concerns are sometimes perceived as “just for rich people.” For example, Inglehart (1995) compared public support for environmental protection in 43 societies. Urban air pollution was worse in China and South Korea, relatively poor at the time but possessing a strong materialist culture, whereas Finland and the Netherlands, affluent countries with a high prevalence of post-materialist attitudes, had the best urban air quality. In fact, a persistent issue is pervasive inequality and lack of social justice within cities (e.g., Schell et al., 2020). Urban social inequities may be felt by those groups living closest to toxic pollution (e.g., near coal fired power stations and waste sites), or on the most damaged (and hence uncultivable and often unsafe) land due to increased exposure to contamination and health risks. These vulnerable groups also experience inequalities in physical infrastructure among neighborhoods, manifesting in differential housing quality, access to green spaces, and availability of in-house water supply or sewerage, for example (Sampson, 2017). Ultimately, neither rich nor poor can escape the worst effects of GCC, but there is an inequitable distribution of environmental hazards among countries and populations, disproportionately affecting the poor (Martin and Boersema, 2011). For example, poverty exacerbates the adverse impacts of climate change on urban dwellers. Marginalized demographic groups such as children, ethnic, religious, and other minorities, often found in cities, face the highest barriers to support, access, and resources, and higher mortality rates in the wake of climate-induced impacts (Global Gender and Climate Alliance [GGCA], 2016). Those with

disabilities are often the worst off, as they are least able to access emergency support in a crisis and are often dependent on the assistance of devices or other individuals (e.g., Gartrell et al., 2020). This intersection is also relevant in that rich cities are better able to create more environmentally diverse and human-supportive urban ecologies, compared to poor cities.

Global climate change, population growth, and in some cases urbanization all contribute to failures of agricultural production and the rising of food prices, malnutrition rates, diseases, and extreme poverty (e.g., Horwood and Frouws, 2021). In turn, these spatial, social and economic disparities pose profound threats to human rights (civil and political rights, as well as economic, social, and cultural rights) and social justice (collective violence, armed conflict and organized violent crime increase) (Levy and Patz, 2015), as well as complex migration patterns (Horwood and Frouws, 2021). For example, informal settlements serving recent migrants are often located on land that is at high-risk due to extreme weather, where residents are further at risk from GCC impacts, food insecurity, and water insecurity (IPCC, 2021b). Regional communities depend on urban ecosystem services to benefit food production, solid waste management, and more (Davids et al., 2021).

### An Ethiopian Perspective

Although cities in the developing world, including Ethiopia, are the locations of expanding populations of growing wealth, one concomitant aspect of urbanization is the increasing concentration of poverty and social inequalities (Marcotullio, 2015; Sampson, 2017), particularly the blooming of informal settlements or slums (United Nations Human Settlements Programme [UN-HABITAT] and IHS-Erasmus University Rotterdam, 2018). As the COVID-19 pandemic demonstrates, those living in dense shanty towns were also not able to obey orders to socially distance for the purely spatial reason that many individuals – over 60% of Africa's urban dwellers, according to UN Habitat estimates – share crowded conditions, lack basic necessities such as in-home water, and have no way to seek isolation. They are also likely to have limited access to vaccines. Urbanization in Ethiopia has increased inequities by reducing the access of the poor to urban land (Mengie, 2015) and enhancing displacement rates (Alene, 2021).

Even in developing countries, urbanites, and especially the poor, have increased access to animal-based foods, sugars, refined grains, and processed foods compared to their traditional diets. This increases rates of obesity and diet-related diseases like diabetes and heart disease (Hawkes et al., 2017). At the same time, however, changes in lifestyle in rural areas also affect rural diets and narrow the gap in obesity levels between rural and urban residents (Tripathy et al., 2016). For an Ethiopian perspective on diet, see Gebremariam et al. (2018).

### Urban Design as a Critical Approach

As recognized by the “One Health” paradigm, all the components we discussed earlier are intimately tied together (Gebreyes et al., 2014). The capacities of cities to mitigate and adapt to GCC, population growth, pandemics, and other stressors will be a crucial predictor of future urban quality of life



**FIGURE 1** | Wood and bags of charcoal displayed for sale by the side of the road in the Somali region of eastern Ethiopia. Photo: Gad Perry.



**FIGURE 2** | Afforestation in the Tigray region of Ethiopia. As in other parts of the country, most such efforts are devoted to *Eucalyptus sp.* of Australian origin which is used in construction, cooking, and other applications. Groves are located in the countryside, on the edges of towns, and even on small plots within cities. Photo: Gad Perry.

(National Academies of Sciences, Engineering, and Medicine, 2019). The ability of cities to support biodiversity is essential for both conservation and human wellbeing (Khatri, 2022). On the one hand, this intersectionality means that problems, and therefore solutions, tend to be complex. On the other, more encouraging hand, attempts to improve one aspect of urbanism often also have positive impacts on others.

Rapid motorization, and with it congestion, is endemic in rapidly-growing developing-country cities, affecting both affluent car-owners and poorer residents who lack personal cars but suffer from air pollution and other problems (Gwilliam, 2003). Although often discussed in an economic context, traffic congestion causes air and noise pollution and other ecological and health problems, in Ethiopia and elsewhere (Sarkar, 2018; Embiale et al., 2019). One example of the multiple benefits of some policies is congestion pricing, which directly charges

road users for the privilege of using publicly constructed infrastructure. Economists explain that this internalizes what is usually an externality – the overuse of roads, with incidental impacts on many non-drivers – and provides user-generated funds for road construction and maintenance (Small, 1992). Congestion pricing is increasingly common in developed nations (Arnott et al., 2005; Santos, 2005), often on highways but increasingly also in urban settings. This reduces traffic jams at peak times, but also improves air quality and health outcomes.

A second example involves urban greenery. Globally, urban tree-cover has been declining as urban impervious cover has increased (Nowak and Greenfield, 2020). This might not be a source of concern if urban trees only served for beautification, but that is far from the case. Urban trees provide shade, clean the air, soak up flood water, help combat climate change, create more livable neighborhoods, create a calming flow on urban traffic, and offer habitat for many species (Nowak and Greenfield, 2020). Similarly, neighborhoods that attract wildlife through diverse vegetation have characteristics that also make them more desirable for humans, resulting in higher real-estate values (Farmer et al., 2013; Perry et al., 2020). Yet investment in and access to urban forestry are often seen as luxuries. Urban tree cover is much higher in developed regions than in developing ones (Nowak and Greenfield, 2020). Multiple studies document the disparity and lack of equity on tree access throughout the US and this lack of access to tree cover, in turn exacerbates socio-demographic health inequities between the wealthy and the poor (e.g., Shanahan et al., 2015). For example, people who live in neighborhoods that lack the cooling benefits of urban trees often cannot afford constant air conditioning operations, thereby compounding their vulnerability to extreme heat events (Jennings and Gaither, 2015). Another study found that within the city of Indianapolis, United States, urban tree cover is significantly related to race, educational attainment, and socioeconomic factors (Lockwood and Berland, 2019). As a result, human wellbeing suffers from the loss of air filtration, shading, flood control, and other services provided by urban trees. Other species that rely on greenery are also edged out. A recent review shows that similar issues exist in the Global South (Rigolon et al., 2018).

### An Ethiopian Perspective

Thoughtful, sustainability-conscious and future-oriented urban design may be especially important in rapidly urbanizing countries such as Ethiopia (e.g., Di Nunzio, 2019). For example, congestion pricing is infrequently deployed as a strategy in the global South (Gakenheimer, 1999), where ineffective governance makes public policy of this kind problematic. Historically, purchases of new cars were taxed at around 400%, making car ownership difficult, but private car ownership was still going up because of poor public transport infrastructure and the continuous growth of cities, especially Addis Ababa. In the remaining cities, private car ownership remained rare. The effects of changes to the tax laws recently covered by the media (Dadhi, 2021) remain to be seen.

Unfortunately, green space tends to be lost as Ethiopian cities are being redeveloped (Girma et al., 2019), adjacent natural areas

are lost to urban expansion, and urban population growth is surpassing urban economic growth and sustainable development. The Trillion Trees Initiative<sup>3</sup> announced at Davos in 2020 and intended to decrease GCC by planting CO<sub>2</sub> consuming trees is very much a Global North initiative, both in its inception and in where it is most likely to succeed. In Ethiopia, use of wood as cooking fuel is pervasive (Figure 1). Often, “reforestation” takes the form of planting non-native species or highly artificial plantations that provide economic but relatively little ecological or cultural value (Figure 2). However, there was an ambitious attempt to address reforestation at a large scale in Ethiopia, to support national green environmental goals. Aptly coined “the Green Legacy of Ethiopia,” the aim was to plant billions of seedlings over a four-year period, starting with 350 million reportedly planted in one day in July 2019<sup>4</sup>. The campaign was personally led by the Prime Minister and was in its second phase prior to the civil war and COVID-19 pandemic starting in 2020 and appears to be ongoing (Anonymous, 2021). Long-term success of this ambitious initiative will depend on consistent follow-up.

### Recent Changes in Ethiopia

Since we began authoring this article, there have been dramatic changes in the security situation, economic position, food security projections, and overall human and ecological health in Ethiopia. These are primarily related to the ongoing conflict (primarily but not exclusively in the north) and the ravages of the COVID-19 pandemic.

The International Monetary Fund is reporting negative GDP growth for Ethiopia in 2021 and has not provided a forecast for 2022 (International Monetary Fund [IMF], 2021). Reduced employment due to the pandemic, combined with rising food prices, has led to increased food insecurity – most specifically among Ethiopia’s urban poor (Harris et al., 2020). In peri-urban and rural areas, the war has prevented many farmers from planting, tending, or harvesting crops, resulting in an especially poor fall harvest. The UN estimates 9.4 million people are in need of humanitarian assistance and hundreds of thousands are on the brink of famine in Afar, Amhara, and Tigray regions (US Agency for International Development [USAID], 2022). Though reliable information is hard to obtain, media reports describe considerable physical damage to urban areas, especially in the north, during the ongoing conflict. Reliable COVID-19 estimates are also in short supply, but a survey conducted in ten cities found significant disruptions, particularly for the urban poor (Harris et al., 2020).

Though it remains a regional inspiration in tree planting (World Economic Forum [WEF], 2020), present challenges erode Ethiopia’s immediate potential to be a leader in the green ecology space, but also create opportunities for making wise choices during the reconstruction that must follow resolution of the crises.

<sup>3</sup><https://www.trilliontrees.org/>

<sup>4</sup><http://www.worldagroforestry.org/blog/2020/06/09/ethiopia-grow-5-billion-trees-second-green-legacy-campaign>

## A Way Forward for Ethiopia

The urban transformation in Africa is rapid and predicted to get larger (Vandecasteele et al., 2018), and so is Ethiopia's. The human population of Ethiopia is growing rapidly, with urbanization increasing. Prior to the present conflict and COVID-19 pandemic, "lack of awareness, financial constraints, insufficient professional knowledge, absence of collaboration and poor public involvement (were) the most influential factors hindering the integration of green infrastructure planning principles into urban development" in Ethiopia (Nowak and Greenfield, 2020). Often, lack of good governance is at least a contributing factor (for present assessment from USAID, see<sup>5</sup> as well as Stiftung, 2020). Nonetheless, Ethiopia's "environmental policy score" (based on data from BTT's 2020 Atlas), which has remained low over the years, has improved slightly from a 2/10 in 2018 to a 3/10 score in 2020. Efforts to reclaim eroded land were successfully undertaken in some areas of the northern highlands, improving land conditions from 2018–2020, despite ongoing soil erosion in many of the country's other regions. Some new techniques for environmental protection were also deployed, funded to a large extent by Western donor countries (Stiftung, 2020).

Some redevelopment efforts, particularly in secondary Ethiopian cities, appear more environmentally conscious and tree-friendly. Addis Ababa has begun creating an urban green space, with both national investors and international organizations assisting in the Beautifying Sheger Project redevelopment of urban riverside (but see critique in Terrefe, 2020). Nonetheless, we suggest that the government of Ethiopia needed to expand its holistic approach to urban planning even before some attention was diverted by the pandemic and war. Incorporating additional inputs from fields including GCC science, social justice studies, ecology, and environmental science helps achieve urban development that can greatly help the country improve its economic output, the quality of life for its citizens, and its sustainability. Although many projects in Ethiopia already include such an extensive team at one stage or another, the comments given by professionals are not always given the importance they deserve in making final plans and are too often considered secondary to political agendas (Terrefe, 2020).

As an example of an area that could benefit from attention, car purchases are very heavily taxed in Ethiopia, but vehicles, particularly old and polluting ones, nonetheless proliferate in cities, particularly Addis Ababa (Kebede et al., 2022). Using market-based or public-transportation-based approaches can help improve social justice (Litman and Brenman, 2012), reduce air pollution, and perhaps reduce the demand for roads in a way that allows more parks to be built, providing habitat for additional species. Market-based taxation discourages unnecessary private ownership of cars and is more consistent with the car-sparse vision of the future being promoted by proponents of self-driving

cars and public transportation, and availability of efficient public transport options helps decrease CO<sub>2</sub> emissions by encouraging efficient transport (Shmelev and Shmeleva, 2018; Cugurullo et al., 2021). Recent investments in light and long-distance rail, especially in Addis Ababa, are encouraging, but the only recent Ethiopian effort we are aware of to deploy congestion pricing is the expressway connecting Addis Ababa to Adama. Thus, and given GCC-caused migration, attention cannot stop with the cities, which are embedded in a broader cultural and economic context (e.g., Horwood and Frouws, 2021).

Apart from feeding the rapidly growing urban and rural populations, agriculture is a crucial source of employment and livelihood in Ethiopia. Primarily rain-fed, it is likely to be especially susceptible to climate-caused disruptions (Antle, 2010), especially drought, with wide implications for the economy. Properly developing cities (especially secondary cities) can offer alternatives to rural dwellers and reduce climate shocks, but attention is needed to the growing impacts of the human population on the rest of the country. National parks such as Bale Mountains, Awash, Gambella, and Simien Mountains have already endured high loss of biodiversity because extensive areas of land were given for mechanized farming, settlement, and infrastructure development (Pieterse and Parnell, 2014; Gashaw, 2015; UNESCO, 2015; Zerga, 2015; Aneseyee, 2016). Recent unrest has further impacted their integrity. Urban populations rely on the ecosystem and economic services provided by such parks, for example as magnets for international tourists (Voronkova et al., 2021), and also benefit from cities such as Addis Ababa serving as tourist magnets in and of themselves (Tessema and Haile, 2022).

Incorporation of ecology as part of a larger urban "green recovery" plan will be essential to long-term health of people and biodiversity (Khatri, 2022) in Ethiopia and elsewhere – especially as the country recovers from civil war and the global COVID-19 pandemic. The recovery that will have to occur following the present tragedy offers an opportunity for Ethiopia to rebuild the country in a direction that is more sustainable and resilient, stabilizes climate impacts, meets growing food demands, protects fresh water sources, and provides protection for ecosystem services, on which Ethiopians rely on for economic recovery and future security, and the biodiversity that supports them.

## CONCLUSION

Globally, cities are receiving growing attention as their economic and cultural importance is recognized and their contributions to quality of life for humans and other species are documented. In developing countries such as Ethiopia, the relatively early stage of urbanization means there is an especially large opportunity to do things *right*, learning from the mistakes made by other countries and skipping technological generations proven to be less than ideal. We hope that Ethiopia and countries like it take advantage of this opportunity, despite present challenges and in preparation

<sup>5</sup><https://roadmaps.usaid.gov/country/ethiopia>

for those coming, such as GCC, war, and COVID-19. Expanded investment will be required as a consequence.

## AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

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## ACKNOWLEDGMENTS

This work was conceived during discussions at two conferences, supported by Humboldt-Universität zu Berlin project number 2111460399 from the Foundation Zwillenberg-Tietz Stiftung to Ulrich Zeller, and by a grant from the Deutsche Gesellschaft für Internationale Zusammenarbeit through the British Council to Stephen Ekwaro-Osire.

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