Catalyzing Innovation
ANNUAL WORLD BANK CONFERENCE ON LAND AND POVERTY
WASHINGTON DC, MARCH 25-29, 2019

# CONTRIBUTION OF URBAN GREEN INFRASTRUCTURE TO ACHIEVE SUSTAINABLE DEVELOPMENT GOALS: AN INNOVATIVE MECHANISM TO BRING DIFFERENT ACTORS TOGETHER

**REVIEW PAPER**

**SISAY NUNE HAILEMARIAM**

World Bank, Ethiopia
shailemariam1@worldbank.org

**Paper prepared for presentation at the**

**"2019 WORLD BANK CONFERENCE ON LAND AND POVERTY"**
**The World Bank - Washington DC, March 25-29, 2019**

**Abstract**

Cities around the world are responsible for 70% of $CO_2$ emission globally. Hence, the Paris Agreement cannot be achieved without action by mega-cities to limit GHG emissions. Similarly, achieving the 17 SDGs will be difficult since SDG-13 is all about climate action. Many Sub-Saharan African cities are not yet taking decisions likely to set stage for the adoption of a model of urban development that can support economic prosperity and manage the rate of growth of carbon emissions. Green Infrastructure (GI) is an innovative concept which refers to interconnected networks of multifunctional features of different land uses having environmental, social and economic benefits. The objective of the review was to assess current state of Green Infrastructure in Ethiopia and make recommendations for policy makers regarding the benefits if fully implemented. The concept is recommended to be captured at the national policy levels. Actions to Catalyze the innovation are recommended.

Key Words: Ethiopia, Green Infrastructure, SDG, Urban

# 1. INTRODUCTION

## 1.1. BACKGROUND

Green Infrastructure (GI) refers to interconnected networks of multifunctional features of different land uses having environmental, social and economic benefits (Benedict & McMahon, 2002; EPA, 2011; Li et al., 2016; Gill et al., 2007; Mejia et al., 2015). European Environment Agency (2011) recognized GI as a concept, which addresses the connectivity of ecosystems to provide products and services and adapt and mitigate climate change. It promotes integrated spatial planning of multifunctional zones through incorporating habitat restoration and other connectivity elements into various land use plans and policies, such as linking peri-urban and urban areas. GI provides a solution for fragmented two or more ecosystems by connecting them, hence, the resilience of such fragmented ecosystems is less than that of connected ecosystems. Restoring, protecting and conserving an ecosystem in the face of increasing population and economic growth seem very far from reality. Therefore, to promote biodiversity conservation, adapt and mitigate climate change as well as ensure environmental health and wellbeing of human society, reconciling human needs with nature through establishment of GI in urban and rural areas is mandatory. It is a reality that urban areas are at increasing trend. Addressing environmental, social and economic dimensions of urban development can be attained with the concept of GI.

Benedict and McMahon (2002) and Wright (2011) have argued that presenting one definition to GI is problematic. Different authors from different background and intention to use it for different objectives may define GI differently. For example Benedict and McMahon (2002) presented a definition agreed by a working group drawn from Conservation Fund and USDA Forest Service in 1999 as follows: “Green infrastructure is our nation’s natural life support system - an interconnected network of waterways, wetlands, woodlands, wildlife habitats and other natural areas; greenways, parks and other conservation lands; working farms, ranches and forests; and wilderness and other open spaces that support native species, maintain natural ecological processes, sustain air and water resources, and contribute to the health and quality of life for America’s communities and people.” The definition highlights the importance of natural environments to human lives. Whereas, the following definition recognizes the significance of concept of planning and design: “Green infrastructure is an emerging planning and design concept that is principally structured by a hybrid hydrological/drainage network, complementing and linking relict green areas with built infrastructure that provides ecological functions (Ahern, 2007).” Furthermore, GI is an ecological framework and can be considered as a strategic approach to the management of environmental resources better, in general, and in urban areas, in particular (Benedict and McMahon, 2002).

It is important to note that GI is also accepted as a relatively new research agenda (Mejia et al., 2015). Benefits of GI depend on the type of definition applied (European Environment Agency, 2011). However, if develop well in urban areas, GI can broadly: (i) improve quality of life, (ii) attract many tourists (both local and international), hence, community-based eco-tourism can be developed, (iii) help conserve biodiversity, (iv) assist in adapting to climate change-related problems and (v) assist in creating more jobs (Benedict and McMahon, 2002; Lennon, 2014; Mejia et al., 2015). GI touches upon different sectors, such as agriculture, water, road/railway and forest/trees. Also, it can affect (positively) cross-cutting issues, such as environment, climate change, and gender. Therefore, GI could help in availing proper or well-functioning coordination within and between sectors; hence, stakeholders' negotiation and implementation of plans could be cost effective. Foster et al. (2011) argued that GI approaches help to achieve sustainability and resilience goals over a range of outcomes in addition to climate adaptation in urban areas. The climate adaptation benefits of GI are generally related to their ability to moderate the impacts of extreme precipitation or temperature. Benefits include better management of storm-water runoff, lowered incidents of combined storm and sewer overflows, water capture and conservation, flood prevention, storm-surge protection, and defense against sea-level rise. Besides, urban forestry, for example, sequesters huge amount of $CO_2$ from the atmosphere and has a cooling effect during hot seasons.

GI is considered as important strategy to implement European Union Biodiversity Action Plan 2020 (European Environment Agency, 2011; Mejia et al., 2015). It provides an opportunity to manage fragmented/disconnected ecosystems, such as fragmented forests, to provide enough products and services as well as adapt and mitigate climate change. Fragmented ecosystems provide fewer benefits than connected ecosystems.

GI has potential to combat climate change and contribute to fulfillment of the Sustainable Development Goals (SDGs) including effective implementation of REDD+. GI provides environmental, social and economic benefits.

Moreover, problem of urban-rural linkage in environmental resources management as well as economic and social benefits can be addressed through GI.

## 1.2. OBJECTIVE

The objective is to review current state of Urban Green Infrastructure in Ethiopia to inform decision makers regarding its benefits and make recommendations to accelerate implementation.

## 2. MATERIALS AND METHODS

Major towns in Ethiopia are the subject of this review. The Ethiopian Ministry of Urban Development and Housing provides the necessary technical support to Federal and Regional towns including Addis Ababa and Dire Dawa. The ministry has developed policies relevant to urban development.

Several per-reviewed articles, grey literatures, policy documents, references from internet, and personal experiences were used as input in the preparation of this manuscript. Additional inputs include welfare reports produced by Ethiopia Central Statistics Agency and data from World Bank web portal.

The review assessed current practice relevant to GI in urban centers in Ethiopia. Since GI is an emerging concept, most of the assessment was limited to literature review.

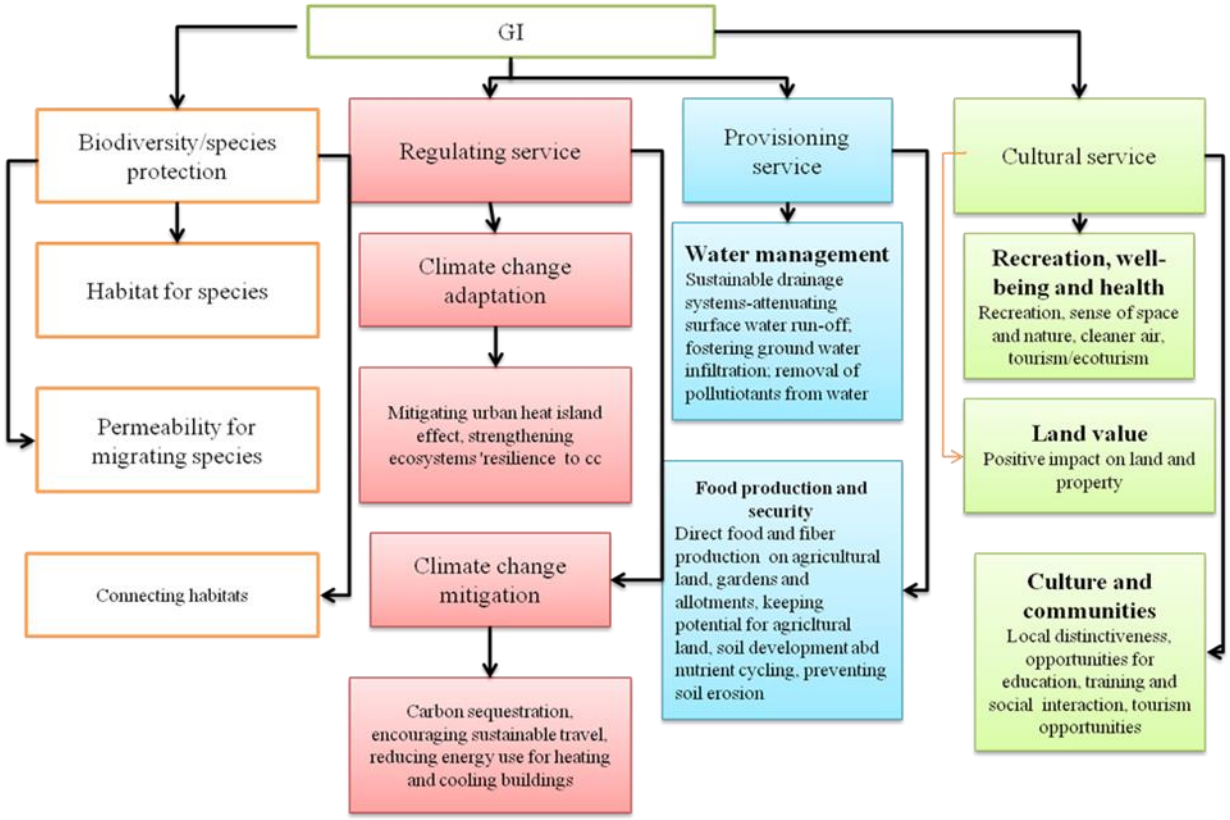
## 3. FINDINGS

### 3.1. WORLDWIDE

Cities around the world are responsible for 70% of $CO_2$ emission globally (UN Habitat, 2016). Hence, the Paris Agreement cannot realistically be achieved without the action by mega-cities to limit GHG emissions (C40CITIES Climate Leadership Group and ARUP, 2016). Similarly, achieving the 17 SDGs will be difficult since SDG-13 is all about climate action, including reduction of GHG (UN, 2017).

Proven initiatives that can reduce $CO_2$ emision should be implemented. GI can be one of such initiatives which can assist in regulating the emission. Moreover, GI is already considered as important strategy to implement European Union Biodiversity Action Plan 2020, climate change adaptation and mitigation (European Environment Agency, 2011; Mejia et al., 2015). Additionally, GI provides an opportunity, among others, to manage fragmented/disconnected ecosystems to provide enough products and services. Fragmented ecosystems provide fewer benefits than connected ecosystems. The benefits of GI are illustrated/summarized in Figure 1 (European Environment Agency, 2011).

**Figure 1 GI Functionality**




Source: (European Environment Agency, 2011)

The benefits of GI are very wide and diverse as witnessed by many authors, such as Benedict & McMahon (2002), European Environment Agency (2011), Foster et al. (2011) and Li et al., (2016). Roe & Mell (2013) have riviewed significant number of articles on GI and summersied them into 13 main functionalities and the functionalities relevant to SDGs are summerised below (Table 1).

Almost all GI functionalities address all the Sustainable Development Goals (Table 1). Some address more than one goal. All of the functionalities can address SDGs 11, sustainable cities and communities. Green spaces in cities improve both urban climate and air quality, lower summer temperature; reduce the amount of flooding after heavy rains, increase recreational value of city life and property values (TEEB, 2010). In addition, restoration of ecosystems and biodiversity, because of GI, provides inspiration and is often an important basis of local culture.

**Table 1 GI functionality and its relevance to SDGs**

| | SDG | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GI functionality | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| Climate change adaptation (flood alleviation and cooling urban heat islands) and mitigation (carbon capture) | | | | | | | | | | x | x | | x | | | |
| Climate control (microclimate cooling, energy savings, atmospheric purification and particle control) | | | x | | | | x | | | x | x | | | | | |
| Water cleansing and control (filtration, absorption and transpiration) | | | | | | x | | | | | x | | | | | |
| Economic development (tourism, eco-agriculture and other jobs, raising property price) | x | x | | | | | | x | | x | x | | | | | |
| Sustainable movement (improved access and circulation) | | | | | | | | | | | x | | | | | |
| Improved community cohesion (creation of social space, empowerment and participatory decision making process) | | | | | x | | | | | | x | | | | | x |
| Providing leisure and recreation opportunities (outdoor relaxation and play) | | | x | | | | | | | | x | | | | | |
| Reconnecting people with nature (space and habitat for wildlife with access for people at the 'doorsteps') | | | | | | | | | | x | x | | | | | |
| Learning opportunities (environmental education, involvement and training) | | | x | x | | | | | | | x | | | | | |
| Local food production (in allotments, gardens and through urban agriculture) | | x | | | | | | | | | x | | | | | |
| Improved health and well-being (lowering stress levels, psychological wellness and providing opportunities for green exercise) | | | x | | | | | | | | x | | | | | |
| Protection of culture, historic features and associations (ancient trees and woodlands and building contexts) | | | | | | | | | | | x | | | | | |
| Enhancing local identity and sense of place (participation in landscape) | | | | | | | | | | | x | | | | | |

Source: (Roe & Mell, 2013)

It is common knowledge that no country has ever achieved middle-income status[1] without a growing urban population (Cartwright, 2015). However, it is very important to note that the current urbanization model is unsustainable in many respects, puts many people at risk, creates unnecessary costs, negatively affects the environment and intrinsically unfair. Therefore, urbanization needs to change in order to address issues, such as inequality, climate change, informality, insecurity and the unsustainable forms of urban expansion (UN Habitat, 2016). There is also a need to pay attention to build the necessary capacity of the responsible institutions and their professional employees to lead the badly needed spatial planning in their respective countries as well as appeal to and negotiate with relevant authorities and stakeholders (Nune et al., 2015).

[1] *China's economic transformation is driven by urbanization and industrialization.*

3.2. AFRICA

Despite the fact that cities are responsible for more than 70% of global $CO_2$ emission (UN Habitat, 2016), an average per capita emission of 69 cities in 35 African countries (emitted at about 240 million tons of $CO_2$, i.e. 43% of the total emissions in the 35 countries) is estimated at 1.8 tons of $CO_2$ in 2012, which is the lowest carbon emission per capita of any region in the world (Godfrey & Zhao, 2015). However, if Business as Usual continues, the 69 cities shall produce or emit about 6 billion tons of $CO_2$ cumulative emission from 2012-2030. This may have significant negative impact on the achievement of Sustainable Development Goal 13.

The African continent is undergoing an unprecedented phase of urbanization (Cartwright, 2015), 11 times faster than the growth rate in Europe (UN Habitat, 2016). The urban population in Africa is expected to triple between 2011 and 2050, from 471 million to 1.34 billion. By the end of 2050, Africa is expected to accommodate 21% of the global urban population (Cartwright, 2015; Godfrey & Zhao, 2015).

Many Sub-Saharan African cities are not yet taking decisions likely to set stage for the adoption of a model of urban development that can support economic prosperity and manage the rate of growth of carbon emissions (Godfrey & Zhao, 2015). This is explained by the prevalence of congestion, growing informality and low densities in urban cores, which undermine the benefits that come from urban agglomeration and the ability to cost-effectively provide mass transit options for the urban poor and growing business. Various reports are cited by Cartwright (2015) on how climate change may affect urban centers in provisioning of food and water in Africa unless thay are prepared sufficiently.

Already, 61% of urban Africans live in informal settlements and 60% engage in informal work that preclude mortgage finance or progressive livelihood strategies (World Bank, 2014). Moreover, the situation is gloomy where “slum settlements are expanding adjacent to “modern”-gated communities and shopping malls, and inter-city freeways connect congested and poorly maintained inner-city streets” (Cartwright, 2015).

In addition to absence of adequate GI, prosperous, socially inclusive and compact cities, serviced by public transport and clean energy, are not the norm or default in Africa (Cartwright, 2015). Compact cities have advantages in concentrating economic and social interactions, reducing unit cost of service delivery. For example, an increase in urban densities to 10,000 from 2,500 people $km^{-2}$ reduces the requirement for water infrastructure from 5.5 to 3.5 meters per person.

The unprecedented urban growth has already caused disappearance of many green spaces[2], including forest areas. Benedict & McMahon (2002) has reported that in many major metropolitan areas in America, green space has disappeared rapidly. At the same time responsible institutions and urban planners are focusing on infrastructure development that is not considering the natural environment. Moreover, 55% of urban population in Sub-Saharan Africa live in slum-like conditions (UN Habitat, 2016).

## 3.3 ETHIOPIA

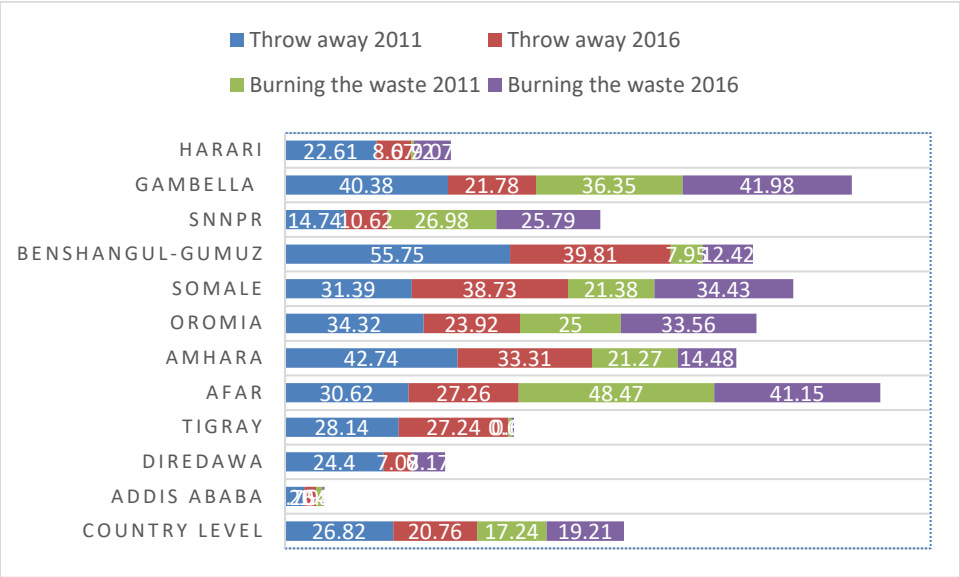
### 3.3.1. Population & urbanization growth and its consequences

The findings from the review revealed that the concept of GI in Ethiopia is at its infant stage despite the emergence of some good stand-alone initiatives in Addis Ababa, such as Repi Land-Fill Power Project, Addis Ababa Light Rail Project and green areas in Addis Ababa and some of the major towns. Moreover, data on GI-related initiatives are rare. The reviewer noticed lack of such initiatives like the ones in Addis Ababa in the other towns.

Urbanization in Ethiopia is projected to increase steadily to exceed 30% by 2030 (Godfrey & Zhao, 2015) from 17% in 2014 (UN Habitat, 2016) even though half of the World's population is already living in urban areas. The total building-related emissions are expected to increase from 1.8 to 6.4 million tons of $CO_2$-e by 2025, of which 25% is attributable to off-grid energy consumption and 75% to waste (MEFCC, 2015). Urban solid municipal waste is managed, mainly, by dumping and burning (Figure 2), while most of the industrial waste water generated is only superficially treated using lagoons. The semi-treated effluents are released into the aquatic system, i.e. rivers and drainage ways.

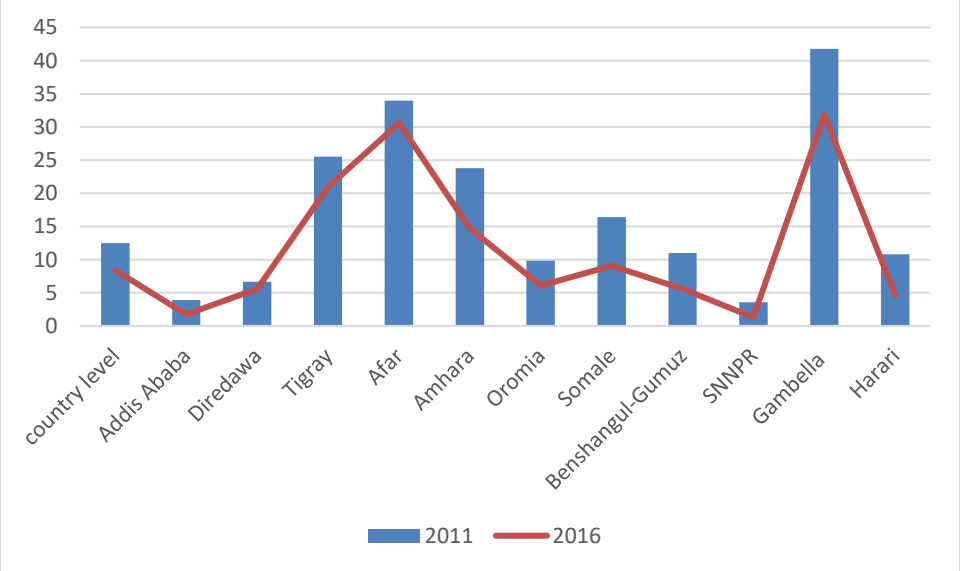
[2] *Green space can include forests, trees along line, water bodies, including wetlands, wildlife habitats, including avifauna, green areas and farm plots. Thus, multi-stakeholder platform it required during designing and implementation of GI (Roe & Mell, 2013). Green spaces in Addis Ababa are categorized as field crop, vegetable farm, public recreation parks, riverside vegetation, plantation forest, institutional (mixed) forest, grassland, street plantation, bare land, special function parks and private gardens (Yeshitela, 2014). These green spaces are classified into three, depending on their size and administrative hierarchy, namely city park (> 10 ha), sub-city park (1 - 10 ha), woreda (district) park (0.3 -1 ha) and neighborhood park (0.1 - 0.3 ha).*

**Figure 2 Distribution of households by type of waste disposal facilities and region-urban-2011 & 2016 (percent)**




Source: (CSA, 2012; CSA, 2016)

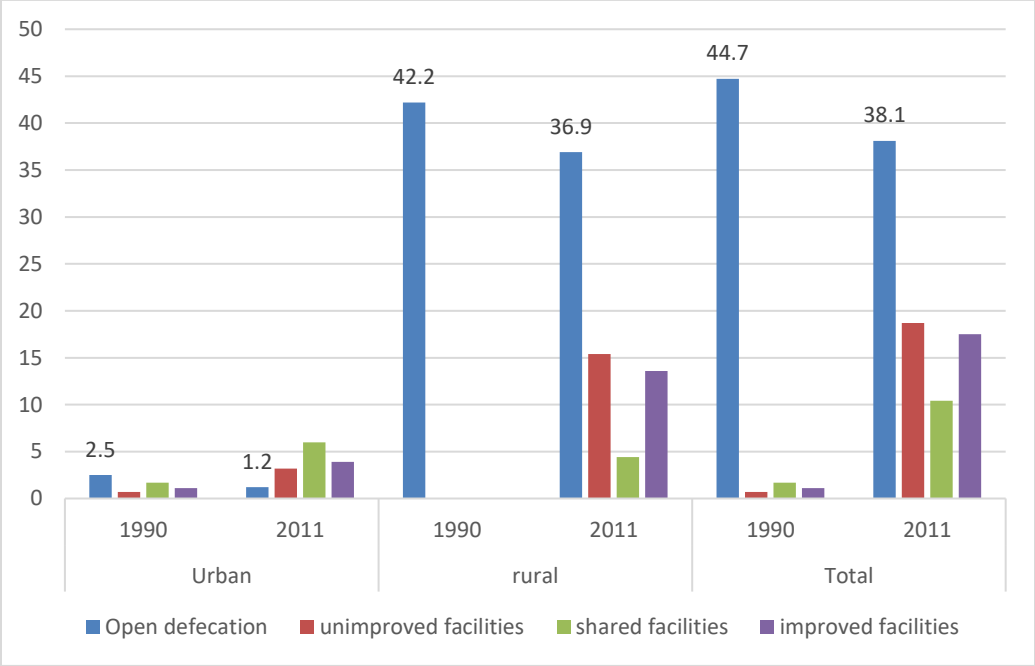
**Figure 3 Percent use of open defecation in urban areas of regions at household level**




Source: (CSA, 2012; CSA, 2016)

Figure 3 shows presence of limitted improvement reagrding access to sanitation facilities between 2011 & 2016 but also provides evedence regarding presence of huge differences between regional towns.

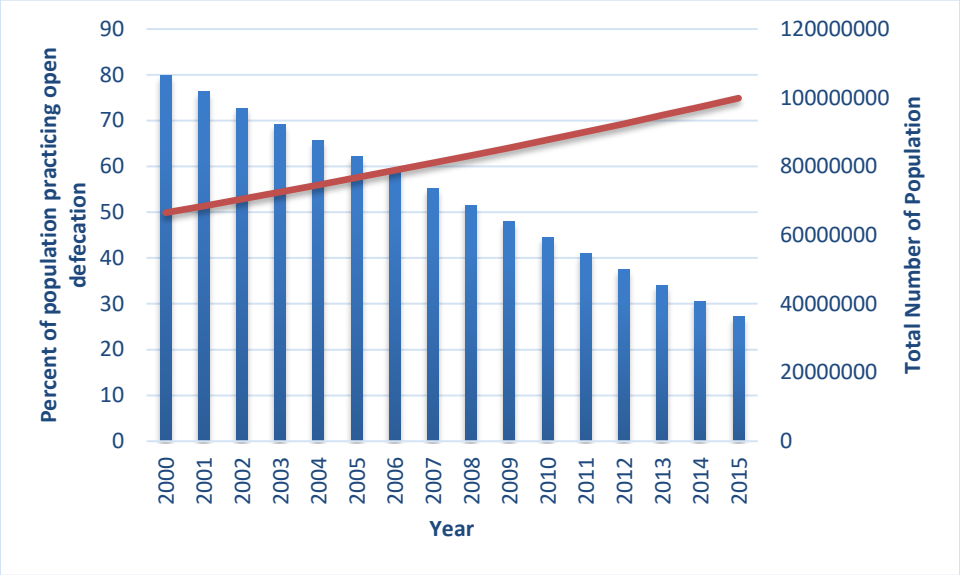
**Figure 4 Access to sanitation facilities-country-wide (Percent)**




Source: (UNICEF, 2014)

Open defecation in urban areas are low compared to people living in rural Ethiopia. According to UNCEF report access to sanitation facilities in urban setting has been improved (Figure 4). However, there is a long way to go to provide sufficient sanitation facility to all in urban and rural areas of the country.

**Figure 5 Percent practicing open defecation between 2000 and 2015**



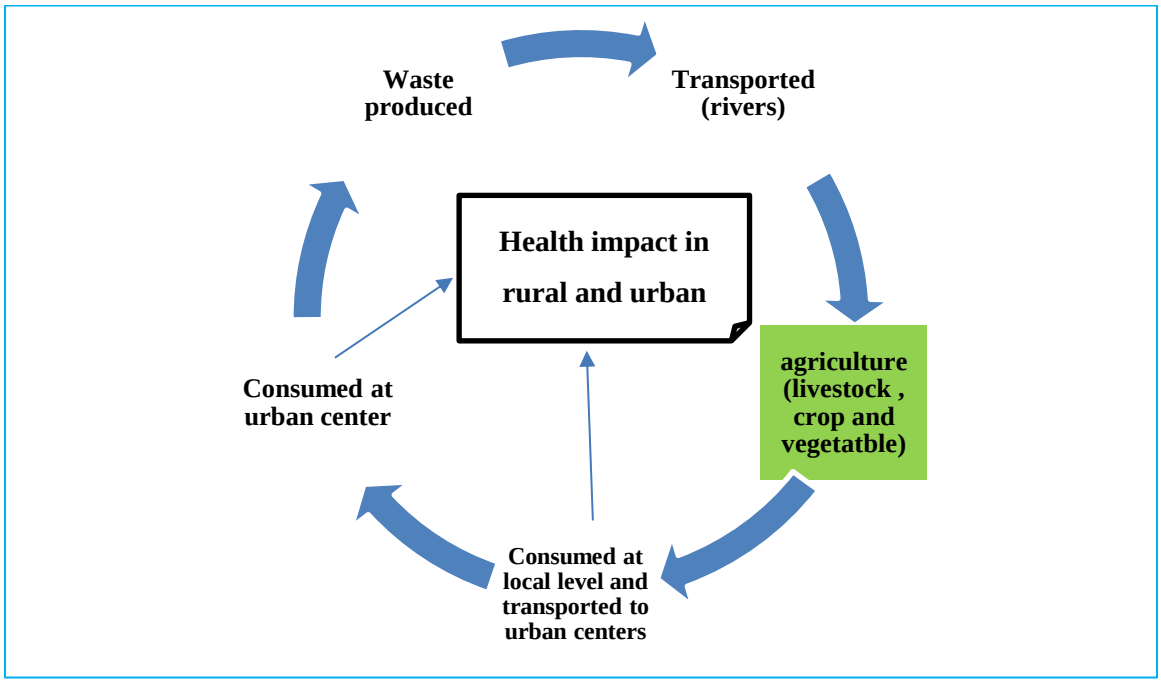

Source: (World Bank, 2018)

Surrounding landscapes [and landscapes beyond] suffer from impact posed by urban centers. Urban centers lack proper toilets for all households (figure 3 & 4), owing to many informal settlements and squatters, and waste treatment sites that are produced by individual households, hospitals, as well as industries. For example, in Ethiopia, the estimated amount of waste water released from major industries (96% come from textile, food and beverage, leather and footwear industries) to the rivers and surrounding areas is nearly 5 million $m^3$ $year^{-1}$ (Fikade, 2017). This waste water has already affected about 10,000 vegetable growers (households) and many thousands of consumers in Addis Ababa, the capital city of Ethiopia, due to high toxic substances, such as arsenic, cobalt, chromium, mercury, nickel and zinc. Polluted water carried by the rivers pollutes the landscape to the extent of affecting health of urban and rural dwellers (Getachew, 2017) (Figure 6).

Solid waste is estimated at 0.17 - 0.48 $kg^{-1}$ $person^{-1}$ $day^{-1}$ in urban areas and 0.11 - 0.35 $kg^{-1}$ $person^{-1}$ $day^{-1}$ of waste in rural areas (MEFCC, 2015). Up to 43% of the waste is collected for disposal in unmanaged landfills while the rest remains in the streets or is dumped in open spaces. In 2017, an unpleasant incident occurred in Addis Ababa where more than 110 people because of the 'unmanaged landfill' in an area called *Koshe* (Al Jezeera, 2017). The incident was reported by national and international media, such as Al Jezeera, Cable News Network (CNN) and the Guardian, among others. Al Jezeera (2017) reported that the area is

used to dump waste originating from different industries, hospitals and households during the last 50 years (Al Jezeera, 2017).

Figure 6 Cyclic impact of waste generated in urban centers



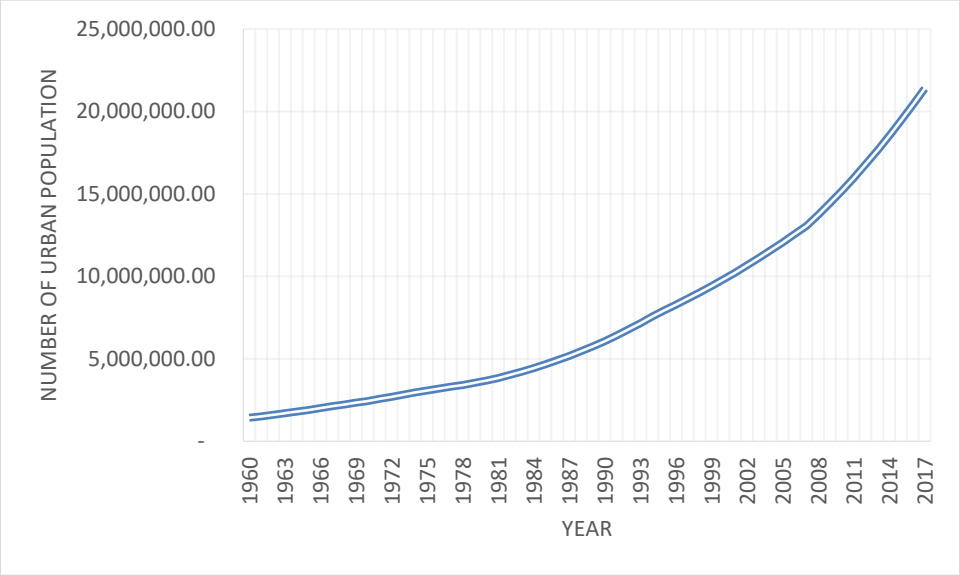

**Source: own analysis**

Quoting an individual, Al Jezeera (2017) indicated that the City Administration has been informed about the concern of piling up of the rubbish for 10 years. About 300,000 tons of waste is collected annually from the Addis Ababa, and most of it is dumped at *Koshe* (The New York Times, 2017). Unless waste is properly managed from the start, the urban centers in another part of Ethiopia may face the same problems in the future.

Many children, youngsters or adults use open fields and forests and river systems as toilets. At a National level in Ethiopia, about 8% of urban and 43% of rural population use open defecation (Beyene et al., 2015). In 2015, according to the World Bank, 7.18% and 32% of the urban and rural population are practicing open defecation respectively (World Bank, 2018). The phenomenon has put many lives at danger because a human stool defecated in open areas within urban centers is the most dangerous matter for our health (Curtis et al., 2000). Diarrheal disease, mainly caused by mostly human stools, kills more young children than AIDS, malaria and measles combined (Curtis et al., 2000). Urban centers are growing in their

population due to, among others, inward migration from rural landscapes. Urban population growth rate in Ethiopia varies from year to year. On average the growth rate of urban population from 1960 to 2017 is 4.8%. The population has increased from 1.4 million to 21.4 million (Figure 7). However, the available social infrastructures, such as proper public toilets, are less than the corresponding demands. The migrants in most cases do not have decent and well-paid jobs to cover costs for better housing facilities.

**Figure 7 Trends in urban population growth**




Source: (World Bank, 2018)

### 3.3.2. Misuse/mismanagement of natural resources in urban areas

Probably, huge amounts of social, economic and environmental benefits are lost due to unwise or destructive use of rivers in both urban and rural Ethiopia. It has been reported that by 2050, annual river run-off and water availability will be reduced by 10-30% in dry regions (Oestigaard, 2016). Already, most of rivers in Ethiopia are dry during the dry seasons, except the ones around forested regions. On the other hand, rivers in urban and rural areas can serve as mediums of food production, e.g. fishery. *Ethiopia, having an estimated inland water body covering about 7,400 km$^2$ of lakes and a total of 7,000 km river length, has a huge potential for fish production* (Ministry of Environment and Forest, 2015). Unfortunately, rivers in urban areas are polluted and provide polluted water for vegetable production (Fikade, 2017). During rainy seasons, huge amounts of waste are carried from upstream to downstream. During dry seasons, rivers in urban areas are used as sites for damping wastes by some urban dwellers. According to CSA (2004), 31.1%

of urban dwellers throw away wastes. In 2016, with huge variation between urban centers in different regions, on average, 21% of urban households in the country throw waste (Figure 2) (CSA, 2016).

The road system in urban areas of Ethiopia, for example, has its own drawbacks. Overflows of water or floods during and immediately after the rainy seasons are common problem every year. There is knowledge gap to build climate-resilient buildings, in general, and road construction, in particular. The size of manhole versus the intensity of rainfall per unit time is not compatible; that creates overflow of water on the surface causing floods. Many households in urban areas have lost and continue to loss their invaluable properties because of flooding (Figure 8).

The numbers of trees and patches of forest or woodland in urban areas are decreasing to give space for real estate development, condominiums and establishments of new settlement. Between 2011 and 2014, green spaces in Addis Ababa have decreased by 20% (Yeshitela, 2014). Mostly, the trees planted in green areas and public parks are exotic in nature against what is stated in the Environmental Policy of Ethiopia (FDRE, 2011).

The Policy advocates reduction of exotic but expansion of indigenous trees to improve ecosystem services. Less emphasis is given for indigenous trees in Addis Ababa as well as other towns. In some places, the trees do not have enough space to develop good root systems. Also, when roads or other initiatives are undertaken the chance of removing the trees is high. For example, the new initiatives, such as the construction of the Addis Light Rail Project, eliminated a lot of trees, but it is not known if the project has supported tree planting to replace the deforested ones.

With population increase (internally or driven by inward migration), size of urban centers increases as well. The size can be increased both formally and informally. According to UN (2017) for every 10% increase in sprawl, there is a 5.7% increase in per capita carbon dioxide emissions and a 9.6% increase in per capita hazardous pollution. This illustrates the important interlinkages across the goals and targets. Therefore, the nexus between urban and rural landscapes are clearly visible where unsustainable rural landscapes force people to migrate and, again, the urban setting creates more pollution where the knock-on effect on rural landscape is inevitable.

Use of Green Area (GA) in urban centers is very much limited. Mostly, these GAs are being used as waste collection points, damping sites and, even, playground for dogs. They are not covered by green plants as expected. The mindset of urban dwellers may be needed to change in order to consider environmental

impacts of waste disposal. Likewise, coordinated efforts between urban dwellers and urban planners in waste management need to be put in place.

**Figure 8 Waste (top photo at the right), flood (top and bottom photos at the left) and local polices to address the disaster at Koshe (bottom photo at the right) in Addis Ababa**


**Source:(https://www.google.com/search?q=flooding+in+Addis+Ababa&safe; http://www.abc.net.au/news/2017-03-12/ethiopia-garbage-dump-landline/8347908)**

### 3.3.3. Barriers for proper implementation of GI

Urban housing projects in Ethiopia (Condominium and Real Estate Development) in different cities and towns are at an increasing rate (own observation). Other infrastructures, such as construction of roads are advancing quickly. However, one could ask whether the expansion of roads, buildings and other impermeable hard surfaces are always subjected to Environmental Impact Assessment. The expansion does not consider sufficient green spaces or GI occupied by networks of multifunctional spaces with trees, shrubs, herbs, grasses and sedges.

Urban areas consume water, energy and food, and produce huge amounts of waste, which has impact on environmental resources. Mostly, resources required for the urban population are derived from the surrounding rural areas and, in some cases, from places that are far away. Efficient and alternative utilization of resources in urban centers may have, to some extent, an impact on the management of natural resources in a given landscape. Charcoal production can be minimized if alternative energy sources, such

as solar and hydropower are used. Alternatively, efficient cook stoves are known to reduce consumption of household energy. In this regard, good planning is required, and the urban areas need to be part of the whole landscape. Considering urban centers into the wider landscape through GI development has double benefits, i.e. (i) controlling unplanned expansion of urban centers to avoid land use land cover change; and (ii) sustainable biomass energy/wood supply to avoid unplanned deforestation and forest degradation.

The impact of pollution and other related problems on biodiversity can be considered as another pressing issue. Avifauna are victims because of urban waste, electric transmission [grid] lines and lack of nesting sites. In modern society, tourism and conservation or protection of biodiversity, such as birdlife and national parks of wild nature are very much interrelated. Many jobs could be created, and income could be generated. Hence, the impact also touches the economy.

Urban biodiversity spots could serve as potential tourist and research sites. However, urban planners are, probably, trained to consider buildings without considering the landscape. Probably landscape architects may consider green areas. But, they may not be ready to consider biodiversity. In fact, a planner needs to have knowledge about landscape ecology, land use planning theory and practice as well as landscape psychology to plan GI (Roe and Mell, 2013).

Even though 20 years old policy on Environment exists in Ethiopia, its implementation is constrained by the lack of capacity at individual and institutional levels. For the last 20 years, among other environmental problems, waste piled up in *Koshe* area in Addis Ababa became the cause of death for more than 110 people, as indicated above. Landfills can lead to vulnerability to climate change by creating potential flood and contamination risks (C40CITIES Climate Leadership Group and ARUP, 2016).

Institutions responsible for planning and implementation of policies lack capacity and commitment to address the needs of the local community. The capacity is highly constrained by staff turnover, insufficient salary or lack of incentives (Nune et al., 2016a). The finding indicates that exiting policies and strategies are not grasped to the same extent by all experts in the field since some say existing policies are sufficient to address problems while others say the opposite.

To manage green spaces, such as GA, there must be adequate budget to cover the costs for development or conservation. The management of a GAs located at different communities, particularly those categorized as neighborhood parks, is left for communities, which are expected to raise the fund. Not all members of communities do have the interest to cooperate, contribute to financial resource as well as knowledge and time for the purpose. Allocating land for such objectives as combating climate change, for example, is a

noble idea, but, allocating the land without enough financial and human resources for development of the area may be the main reason responsible for the *weak* management of the GAs. Land use policy and forestry are underfunded in most of the sectorial offices responsible for natural resource management (Nune et al., 2016a).

Lack of coordination in planning, including land use plan, is manifested by actions on the ground where utility authorities, such as water and telecommunication, destroy asphalt roads, which may have been built just recently to put a system underground. Many constructions related to building also contribute for road destruction. Common result framework useful for the management of initiatives, such as GI in different sector offices is unthinkable. Reasons for lack of such common result framework are lack of interest, lack of information, lack of knowledge and transaction costs (Nune et al., 2016a). Uncoordinated efforts doesnot help to move forward (Figure 9).

**Figure 9 Lack of coordination**


Source: (Jaznaju, 2013)

Even though some policies are in favors of developing green areas and protection or conservation of the environment and keeping the urban centers from pollution, the price of land in urban centers is, probably, a limiting factor for the development of GI. With the current inflated land price, e.g. in Addis Ababa, it may still be unrealistic for any city/urban administration to dedicate land for green areas or sport fields. Consequently, even if it is hard to estimate the per capita GI, one may conclude that Addis Ababa and the rest of urban centers in Ethiopia lack proper and sufficient GI.

Even though some GI components exist in urban areas in Ethiopia, their sustainability is limited by: (i) proclamation and structural plan; (ii) lack of connectedness, which means there is no network or system; and (iii) lack of institutional and professional capacity, budget and coordination.

### 3.3.4. Policies supporting implementation of GI

Policies supporting GI exist even though there are no GI specific ones. Agenda 2063 aspires for African citizens to have decent and affordable housing in clean, secure and well-planned environments (AUC, 2015). To fulfil the aspiration, the agenda has indicated four means, i.e.: (i) providing access to affordable and decent housing to all in sustainable human settlements; (ii) ensuring effective and territorial planning and land tenure, use and management systems; (iii) ensuring balanced development of all human settlements while embracing a rural urban continuum; and (iv) improving the livelihoods of the great percentage of the people working and living in slums and informal settlements.

The Constitution of Ethiopia (FDRE, 1995) contains a clause (Article 44 [1]) on environmental rights, which states that "*All persons have the right to a clean and healthy environment*" (FDRE, 1995). The House of Representatives (HR) established various standing committees and mandated the committees to oversee and support the implementation of policies, strategies and programs approved by the same. Among such standing committees, the Urban Development and Construction Affairs Standing Committee is worth mentioning. Because this committee is mandated to oversee and support urban development as well as address social and environmental problems without undermining the economic development.

Environmental Policy of Ethiopia (EPA, 1997) states the recycling of liquid and solid wastes from homesteads and establishments (industries, hospitals and hotels) to produce energy, fertilizer and other useful products.

The Government of Ethiopia (GoE) has also issued Proclamation No. 574/2008 to provide for urban plans (HR, 2008). Following the Proclamation, a manual for structural development plans was issued in 2012 as an instrument for implementation. The Proclamation and the manual contain, more or less, the same thing regarding the greening of Ethiopia.

Additionally, the GoE issued an Urban Development Policy in 2005 (in the Amharic language). Development of competitive urban centers to attract various investors and attract quality human capital is highlighted in the Policy.

## 4. DISCUSSION

Social, economic and environmental benefits of GI are recognized in the literature. The importance of GI is mainly acknowledged in North America (Benedict and McMahon, 2002), Europe (European Environment Agency, 2011), but less in Africa. On the other hand, urbanization in Africa is increasing at a faster rate while infrastructure needed by the society is very slowly progressing. Implementation of GI should be accelerated to combat climate change related impacts, such as flooding, because such accidental calamities are frequent in most African urban areas. If business as usual continues, in the Africa urban areas may not be able to achieve the SDGs. The role of trees and other vegetation as GI in urban areas is well accounted by, for example, Gill et al. (2007).

The limited data collated from different sources indicate that GI *per se* is not yet in the agenda of many discourses in Ethiopia. Due to little attention given to GI, interventions related to GI are insignificant. Urban areas are expanding at a faster rate, leading to direct impact on land use and land cover change, and other social infrastructures. Per capita waste generation and informal settlement are at an increasing rate because of population growth and inward migration. Unavailability of proper facilities and tools and equipment to convert waste to useful products exasperate the problem.

On the other hand, following the path of GI for urban centers in Ethiopia or Africa at large has many advantages. One study indicates that financial savings that could be gained by cost effective investments, such as in building energy-efficient, small-scale renewable and more efficient vehicles and transport systems could be between 1.7 and 9.5% of annual city-scale GDP compared with the business-as-usual trend (Gouldson et al., 2014). Additionally, implementation of GI can provide job opportunities to many unemployed. For example, waste management, production of seedlings, preparation of planting sites, planting and tending, construction of trails and cycle lanes can absorb many unemployed people. Production of technologies suitable for adapting and mitigating climate change in the transport sector, building sector, agriculture and water management are opportunities waiting for many African young entrepreneurs.

As it is mentioned above, streams and rivers are not utilized in a way that can contribute to food and nutrition security, particularly in Ethiopia. In most cases, the river system is used for agriculture and domestic use by the small holder farmers. But, the rivers need to be cleaned to guarantee health safety. Once the rivers are cleaned from pollution from urban households, open defecation and industrial waste, sustainable flow of water can provide fish, tourism and other products in addition to the small-scale irrigation.

Capacity of urban (spatial) planners and local administration to guide local communities or urban dwellers, private sectors and NGOs in creating synergies to design and implement GI should be available. Additionally, sufficient budget for the implementation of GI-related action should be allocated. Global temperature is rising. Cities need to become resilient and sustainable more than ever (Pelorosso et al., 2015).

Limiting GHG emission, either in rural areas because of land use land cover change or urban centers because of transportation, waste management and other factors, must go hand-in hand. As such, the urban development choices adopted in African cities in the next decade will not only affect urban residents, but will have global implications (Cartwright, 2015).

African urban centers have population less than world average. Hence, African urban centers do have an opportunity to grow green and sustainable because most of the urban areas are under construction. Hence, urban planners and policy developers in Africa must take the green growth path to make use of the existing opportunity so that urban population and sustainable cities can grow together. Failure in achieving sustainable cities worldwide will affect 50% of the world population. Hence, it will be unrealistic to achieve the SDGs.

There are policies which can support the design and Implementation of GI in Ethiopia. However, the barriers discussed above need to be addressed sufficiently. Proper planning and implementation of GI requires knowledge/capacity at system, organizational and individual level, finance, and stability in institutional arrangements, among others. Institutions may limit the success of urban GI.

It is worth noting that the role of cities or urban areas to achieve SDGs and combat climate change is significantly high because urban areas are, among other things, home to all or majority of decision makers (Doll, 2015). What may be required is bringing those different decision makers or actors together to plan together. GI, owing to its multiple benefits, is the best concept to bring these different actors together.

Finally, leaders of urban areas should take part in any discourse regarding rural development, in general, and landscape approach, in particular. Because, urban centers are less likely considered in rural development-related consultations and discussions; hence, the issue of environmental resources conservation and management (ERCM) may be a bit far from them. In many cases, it is the rural communities (farmers or pastoralists) who are mostly consulted regarding ERCM, but not the urban dwellers as far as Ethiopia is concerned. Therefore, in the future, urban centers should be engaged in the discussion that may lead to landscape approach.

In conclusion, sector-based approach, which is inefficient and ineffective, should be transformed to GI approach in urban settings, and reforming of institutions and their planning systems (Nune et al., 2016a) should be given the highest priority to address the already available initiatives, such as REDD+, SDGs and other emerging issues.

## 5. CONCLUSION

The finding from the assessment of GI in Ethiopia shows that proper GI is not yet in any of the government plans. Considering or implementing GI in urban centers would complement the implementation of SDGs, among other benefits.

Most urban centers in Ethiopia are avenues for old vehicles, which consume huge amount of fossil fuels. Fossil fuel is the most important non-renewable natural resource contributing to GHG emission and, hence, global warming. Replacing this old and inefficient system with other options, such as use of efficient vehicles, alternative fuels (bio-diesel), improving infrastructure, promote mass transportation, use of non-motorized transport, such as bicycles, are proposed by the Ethiopian Government. Such initiatives need to be translated into action in a faster rate than current mode of operation. The initiatives should not be limited to certain cities. They should also include important towns.

The review indicated that total building-related emissions in Ethiopia are expected to rise to 6.4 million tons of $CO_2$-e by 2025, of which 25% is attributable to off-grid energy consumption and 75% to waste. Initiatives exist to modernize energy in urban areas in Ethiopia to reduce emission from biomass burning and, among others, reduce negative impacts on human health. Some initiatives, such as the Repi project in Addis Ababa, can increase electricity supply for household use as primary output and, above all, they can be instrumental in mainstreaming of waste management strategies into national programs. However, significant amount of waste is not being used in the capital Addis Ababa as well as urban areas located at regional states.

It is high time now to convert waste to money. The design and operation of waste management systems must be sensitive to changes in future climate. Diverting waste from landfills through recycling initiatives and circular economy approaches can assist in improving the resilience of the city to future climate change. Waste management can create many jobs in addition to its impact on climate change.

Coordinated efforts and common planning tools are required to make GI fully functional. GI is hardly possible to implement it at individual or at a single sector level. Since it required multidisciplinary skills and knowledge (environmentalist, engineers, urban planners, landscape architect, etc.) GI opens an

opportunity to bring these multidisciplinary skills and knowledges to work towards sustainable city/urban center.

## 6. RECOMMENDATIONS

Green Infrastructure is very important concepts that Ethiopian (or African) policy makers should consider during development of policies, strategies, annual and multiyear plans to fulfill commitments to their citizens and respond to the international commitments that they have made, e.g. Paris Agreement and SDGs. The concept is recommended to be captured at the national policy levels. Also, AUC and NEPAD can capture the concepts at their policy levels.

### 6.1 CATALYZING INNOVATION

Gi is an innovative concept which can reduce GHG emission, increase social amenities and social capital, and can make the economy sustainable. Hence, catalyzing this innovative concept is urgently needed.

As an entry point, the followings are recommended:

a. Revise urban policies, strategies and working documents to address GI fully. The existing policies are developed to reflect sectoral issues and are divided by sectoral walls. Therefore, policy makers need training and their awareness should be raised prior to the revision. Policy implementers also require trainings and awareness creation.
b. Establish GI technical and vocational training centers to train cadres of GI.
c. Revise curricula at universities and colleges to address GI.
d. Reform institutions to dissolve sectoral thinking and create common planning framework.

Establishing think-tank group might also assist the current urban planners and lower level implementers to integrate GI into their annual plans.

## 7. REFERENCES

African Union Commision. (2014). *Agenda 2063: The Africa We Want.* Addis Ababa: AFrican Union Commission. Retrieved October 23, 2016, from http://www.un.org/en/africa/osaa/pdf/au/agenda2063.pdf

Ahern, J. (2007). Green Insfrastructure for cities:The Spatial dimension. In V. Novotny, & P. Brown (Eds.), *Cities of the Future Towards Integrated Sustainable Water and Landscape.* London, UK: IWA Publishing. Retrieved April 12, 2017, from http://citeseerx.ist.psu.edu/viewdoc/download;jsessionid=EA86559DBA2F6B7109DA48E546326DC3?doi=10.1.1.558.8386&rep=rep1&type=pdf

Al jezeera. (2017, March 14). Death toll soars to 82 in Addis Ababa rubbish landslide. *AlJazeera Media Network*. Retrieved March 27, 2017, from http://www.aljazeera.com/news/2017/03/addis-ababa-death-toll-hits-113-rubbish-landslide-170315165759540.html

Benedict, M. A., & McMahon, E. T. (2002). Green Infrastructure: Smart conservation for the 21st Century. *Renewable Resources, 20*(3), 12-17. Retrieved December 08, 2016, from http://www.sactree.org/assets/files/greenprint/toolkit/b/greenInfrastructure.pdf

Beyene, A., Hailu, T., Faris, K., & Kloos, H. (2015). Current state and trends of access to sanitation in Ethiopia and the need to revise indicators to monitor progress in the Post-2015 era. *BMC Public Health, 15*(451), 1-8. doi:DOI 10.1186/s12889-015-1804-4

C40CITIES Climate Leadership Group and ARUP. (2016). *Deadline 2020: How cities will get the job done.* C40 CITIES. Retrieved December 08, 2016, from http://sdg.iisd.org/news/mayors-highlight-cities-role-in-climate-mitigation-adaptation/

Cartwright, A. (2015). *Better Growth, Better Cities: Rethinking and Redirecting Urbanisation in Africa.* African Center for Cities. Retrieved 01 03, 2017, from http://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2016/04/NCE-APP-final.pdf

CSA. (2004). *Welfare Monitoring Survey 2004: Analytical report.* . Addis Ababa: CSA.

CSA. (2012). *Welfare monitoring survey 2011.* Addis Ababa: CSA. Retrieved August 28, 2018, from http://www.csa.gov.et/survey-report/category/356-wms-2016

CSA. (2016). *Welfare Monitoring Survey 2015/16.* Addis Ababa: CSA. Retrieved August 28, 2018, from http://www.csa.gov.et/survey-report/category/356-wms-2016

Curtis, V., Cairncross, S., & Yonli, R. (2000). Domestic hygiene and diarrhoea-pinpointing the problem . *Tropical Medicine and International Health*, 22-32.

Doll, C. (2015, September 19). Cities Should be at the Heart of the SDGs. *UNU 17 Days, 17 Goals*. Retrieved March 31, 2017, from https://unu.edu/publications/articles/cities-heart-of-sdgs.html

Environmental Protection Authority. (2011). *Climate Resilient Green Economy: Green Economy Strategy.* Addis Ababa: EPA.

European Environment Agency. (2011). *Green infrastructure and territorial cohesion: the concept of green infrastructure and its integration into policies using monitoring system.* Luxembourg: EEA. Retrieved Febraury 07, 2017, from eea.europa.eu

FDRE. (1995). Constitution of the Federal Democratic Republic of Ethiopia. *Proclamation No. 1*. Addis Ababa: Berhanena Selam Printing Press.

FDRE. (2011). *Ethiopia's Climate Resilient Green Economy: Climate Resilience Strategy Agriculture.* Addis Ababa: Ministry of Agriculture.

Fikade, B. (2017, March 25). Pullution Affecting vegetable growers,consumers. (A. Seyoum, D. Amensisa, W. Berhanu, K. Bekele, & Y. Abiye, Eds.) *The Reporter, XXI* (1072), p. 40. Retrieved from www.thereporterethiopia.com

Foster, J., Lowe, A., & Winkelman, S. (2011). *The value of green infrastructure for urban climate adaptation.* The center for clean air policy. Retrieved February 02, 2017, from www.ccap.org

Gill, S. E., Handley, J. F., Ennos, A. R., & Pauleit, S. (2007). Adapting Cities for Climate Change: The Role of the Green Infrastructure. *BUILT ENVIRONMENT, 33* (1), 115-133. Retrieved 12 7, 2016, from http://urbanspace.rec.org/files/Article_Gill_Adapting_Cities_for_CC.pdf

Godfrey, N., & Zhao, X. (2015). *The Contribution of African Cities to the Economy and Climate: Population, Economic Growth, and Carbon Emission Dynamics.* London: NCE-The Global Commision on the Economy and Climate. Retrieved 01 02, 2017, from http://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2015/09/NCE-African-Cities-Economy-Climate_technical-note.pdf

Gouldson, A., Colenbrander, S., McAnulla, F., Sudmant, A., Niall, K., Sakai, P., . . . Kuylenstierna, J. (2014). *The Economic case for low Carbon Cities.* Stockholm Environment Institute. Retrieved 01 03, 2017, from http://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2016/04/Low-carbon-cities.pdf

Jaznaju. (2013, May 12). Horses pull carriage in opposite direction. Drawception. Retrieved 2 12, 2017, from https://drawception.com/panel/drawing/vGjH3336/horses-pull-carriage-in-opposite-directions/

Li, B. B., Meyers, J., & Beaty, M. (2016). Urban Green Infrastructure impacts on Climate Regulation Services in Sydney, Australia. *Sustainability*, 1-13. doi:10.3390/su8080788

MEFCC. (2015). *Mid-Term Progress Report from October 2012 to November 2015 of Ethiopia's R-PP implementation.* Addis Ababa: National REDD+ Secretariat, MEFCC.

Mejia, C. V., Shirotova, L., & de Almeida, I. F. (2015). Green Infrastructure and German Landscape Planning: A comparison approach. *Urbni izziv, 26*(special), 525-537. doi:DOI: 10.5379/urbani-izziv-en-2015-26-supplement-002

Ministry of Environment and Forest. (2015). *Ethiopia's second national communication to the United Nations Framework Convention on Climate Change (UNFCCC).* UNFCCC. Retrieved November 20, 2018, from https://unfccc.int/resource/docs/natc/ethnc2.pdf

Nune, S., Soromessa, T., & Teketay, D. (2015). Non-carbon benefits for effective implementation of REDD+: The case of Bale Mountains Eco-Region, Southeastrn Ethiopian. *African Journal of Environmental Science and Technology, 9(10)*, 747-764. doi:10.5897/AJEST2015.1953

Nune, S., Soromessa, T., & Teketay, D. (2016a). Institutional arrangements and managment of Environmental Resources in ethiopia. *Environment and Natural Resources Research, 6*, 67-87. doi:10.5539/enrr.v6n1p67

Oestigaard, T. (2016, June). Water and food in Africa. *The Nordic Africa Institute*. Bergen: UiB. Retrieved February 10, 2017, from http://www.uib.no/sites/w3.uib.no/files/attachments/terjeoestigaard.pdf

Pelorosso, R., Gobattoni, F., Rosa, D. L., & Leone, A. (2015). Ecosystem services based planning and design for urban green infrastructure for sustainable cities. *Italia 45--45:Radici, Condizioni, Prospettive* (pp. 763-769). Venezia: Planum. Retrieved February 01, 2017, from https://www.researchgate.net/publication/299411561

Roe, M., & Mell, I. C. (2013). Negotiating value and priorities: Evaluating the demands of green infrastructure development. *Journal of Environmental Planning and Managment, 56*(5), 650-673. doi:10.1080/09640568.2012.693454

TEEB. (2010). *The Economics of Ecosystems and Biodiversity for local and regional policy makers.* London: Earthscan.

The New York Times. (2017, March 12). Landslide at Ethiopia Garbage Dump Kills at Least 35. Retrieved March 28, 2017, from https://www.nytimes.com/2017/03/12/world/africa/addis-ababa-ethiopia-garbage-landslide-dump.html?_r=0

UN. (2017). *Progress towards the sustainable development goals: Report of the secretary general.* Economic and Social Council. Retrieved August 7, 2017, from http://www.un.org/ga/search/view_doc.asp?symbol=E/2017/66&Lang=E

UN Habitat. (2016). *Urbanisation and Development: Emerging Futures.* Nairobi: UN Habitat. Retrieved 01 04, 2016, from http://nua.unhabitat.org/uploads/WCRFullReport2016_EN.pdf

UNFCCC. (2011). *Report of the Conference of Partices on its Sixteenth Session, held in Cancun from 29 Novemebr to 10 Deccember 2010.* Cancun: UNFCCC. Retrieved April 23, 2016, from https://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf

UNICEF. (2014). *UNICEF Sanitation Priority Country Factsheet 2014.* UNICEF. Retrieved 08 23, 2018, from https://www.unicef.org/ethiopia/Ethiopia_Fact_Sheet_Jan_2014._final.pdf

World Bank. (2014). *World Development Idicators.* Washington: World Bank. Retrieved February 26, 2016, from https://data.worldbank.org/data-catalog/world-development-indicators

World Bank. (2018). *World Development Indicators.* World Bank. Retrieved August 29, 2018, from https://data.worldbank.org/country/ethiopia

Wright, H. (2011). Understanding green infrastructure: the development of a contested concept in England. *Local Environment, 16*(10), 1003-1019. doi:http://dx.doi.org/10.1080/13549839.2011.631993

Yeshitela, K. (2014). *Water Resilient Green Cities in Africa: Green Area Typologies and mapping of Green structure in Addis Ababa and Dar Es Salaam.* Copenhagen: Danida.