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Report

African Cities: Is there Space for Circularity?

Main facts, trends and case studies on African urban Circular Economy

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Abstract

In this report several definitions of circular economy reported in the literature are introduced and discussed. From the first definitions where Planet Earth is described as a closed system with limited assimilative capacity, to the evolution of the concept focused on raw materials, resource flows and closed loops. A particular emphasis is then given to the application of circularity to the urban context, focusing on the African continent. The problem with the concept of urban circularity is that still remains on general assumptions due to a lack of examples about circular cities and an overall confusion in defining the indicators that make circular a city; the document proposes some frameworks to define it. The few cases known are mostly focused on high-income economies, indeed in Africa the difficulty of acquiring information on cases of circularity is challenging due to a lack of literature. Nonetheless, the absence of notions does not exclude the existence of relevant cases of circularity and sustainability. Indeed, making the shift towards circular behaviours might be more 'intuitive' in low and middle-income economies, requiring less behavioural changes compared to the richer counterparties. To conclude, this essay attempts to shorten the distance between the academic debate concerning circularity and the on-field initiatives, providing a method to classify the existing case studies in Sub-Saharan Africa.

01 Introduction

«We declare, with more than 11,000 scientist signatories from around the world, clearly and unequivocally that planet Earth is facing a climate emergency» (Ripple et al., 2020). Despite not being new to similar alarms, this letter was published in November 2019 signed by scientists from 153 countries [1] The First World Climate Conference has been held in Geneva 41 years ago where scientist from 50 nations met and agreed on the urgency to act. The trends for climate change were alarming and since then similar warnings have been made through the years (1992 Rio Summit, 1997 Kyoto Protocol and 2015 Paris Agreements). Recently, experts have insisted on explicit warnings of insufficient progress (Ripple et al., 2020). Despite several negotiations, business as usual have been conducted, triggering an unexpected crisis acceleration. Data (Ripple et al., 2020) confirm greenhouse gas emissions are rapidly arising and effects on the planet's climate are worsening.

The climate change debate focuses mainly on global surface temperature and puts out the difficulty to capture the relevance of human activities and the real dangers of a warming planet (Briggs et al., 2015). Scientists' warning "suggests six critical and interrelated steps" that policymakers and humankind must regard to tackle a mitigation of climate change effects. Four steps are repeatedly affirmed – energy efficiency, short-lived pollutants, biodiversity preservation and reduce consumption of meat – while the remaining two deal with economic and population growth, poorly debated, notwithstanding being the most important drivers of increases in CO_2 emissions from fossil fuel combustion. Therefore, drastic transformations regarding economic and population policies are necessary (Ripple et al., 2020).

Economic and population growth

The last century witnessed enormous growth in population and global economy leading to intensive consumption of our planet's resources (Krausmann et al., 2009, Prendeville et al. 2018). Notably, industrial development induced the inputs of materials, the outflows of wastes, the production of emissions and the corresponding environmental change (Krausmann et al., 2009). Over the past 100 years, material consumption has grown eightfold and is expected to triple by 2050 (UNEP, 2011). The population is expected to increase by 2 billion persons in the next 30 years, period in which the Sub-Saharan Africa region is projected to double the population (UN, 2019). Besides, annual global waste is expected to grow from the current 2.01 billion tonnes to 3.40 over the same period, with a profound difference referred to income level: increase per capita waste projection

1 The letter and the 11,258 scientist signatories list is available at: https://academic.oup.com/bioscience/article-abstract/70/1/8/5610806

is estimated to be 19% in high-income countries and by 40% or more in low-income countries (World Bank, 2018). The probable consequences of these trends include future scarcity of resources, fertile land, clean water and air (EMF, 2012) leading to global price volatility. For decades, economic growth has been accomplished through drawing down natural resources, impeding stocks to regenerate. It is widely known that the system cannot be sustained anymore (UNEP, 2011). Each year, the annual global amount of resources ends faster, and the Earth overshoot day falls always first compared to the previous year. In Figure 1 it is possible to observe that the 2020 overshot day fell more than 3 weeks later than in 2019[2]. The spread of the COVID-19 pandemic has caused a shrinking of the global ecological footprint, demonstrating how rapid changes in the consumption patterns of natural resources are possible. The concept of circular economy (CE) offers an opportunity to respond to these challenges and drives society into a sustainable development changeover, from the linear 'take, make, dispose' economy to a 'cradle to cradle' system (EFM, 2019).

Cities

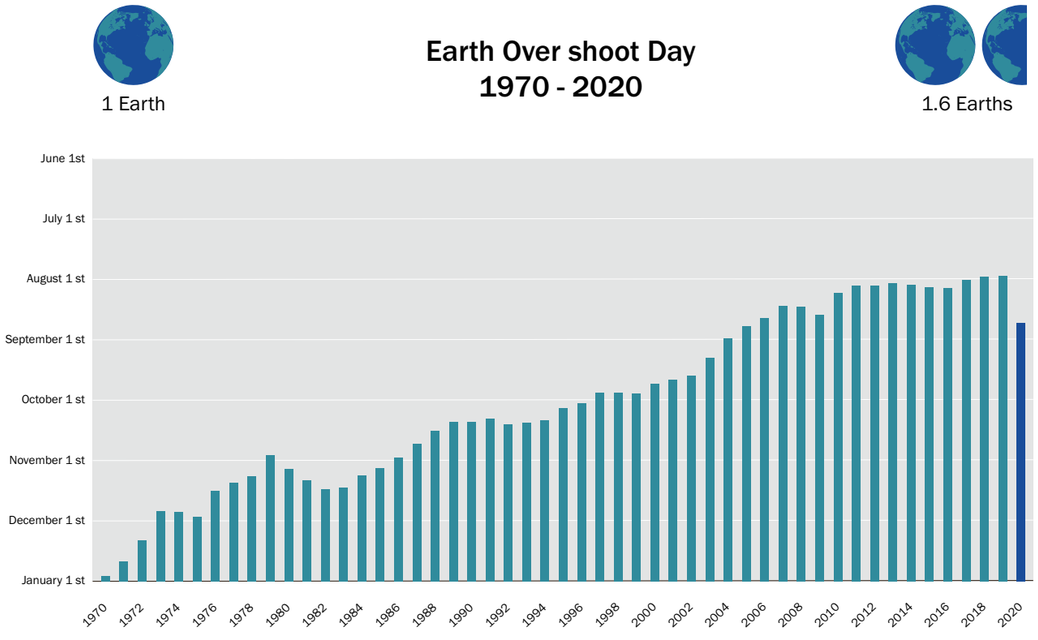
In particular, cities are the place where population and economic growth take field even faster. They are complex entities formed by flows of energy, material and information where people and their sustainable future takes place. The European Commission recognizes the role of cities in the future transition to a sustainable community (EC, 2017). The UN Department of Economic and Social Affairs also notes that urbanization trends are paramount to implement the 2030 Agenda (UNDESA, 2018). Urbanization means that 75% of global natural resources and 80% of the global energy supply consumption occur in cities (EMF, 2019). Indeed, cities produce 50% of global waste and 60-80% of GHG emissions (EMF, 2019). Besides, half of the global population now lives in cities becoming two-thirds by 2050 (Prendeville et al., 2018).

These trends are faster and with higher impact in low and middle-income countries, especially in the African continent, the last one to start the economic developing process. Africa is already urban (Figure 2) and the urban population doubles every 10 years (OECD, 2020). Consequently, this is the geographical area on which depends the future of our planet, and where it urges to focalize our efforts.

This work aim is to approach the concept of circularity to define what is a circular city (CC) and demanding whether it is the proper time to debate on CC in developing countries, notably in the African continent, due to the incredible growth of the urbanization and population trends.

Despite literature is lacking and the few existing articles are written according to an 'occidental' mindset, the evidence of an increased attention on the topic lies in several new organizations and think thank born within the last few years. Finally, the article intends to shorten the distance between the academic debate and the initiatives on field, providing a number of case studies regarding the African Sub-Saharan area.

Figure 1. The Earth Overshoot Day of the last 50 years. Source: https://www.overshootday.org/



2 Numbers reported at overshootday.org

02

Meaning and definitions of Circularity

This section provides a brief history of the concept of circularity, collects different definitions and their applications, and discusses the difficulties in establishing appropriate guidelines for a circular city.

Circular economy is not a recent concept as Geissdoerfer et al. (2017) trace the diffusion of the idea since the late 1970s. According to several authors, the introduction of CE is attributed to Pearce and Turner (Andersen, 2007; Ghisellini et al. 2016; Su et al. 2013). They scrutinised the linear characteristics of the contemporary economic system, where natural resources are both providing input for production and serving as a sink for outputs (waste). This has been influenced by Boulding's (1966) work, where Planet Earth is described as a closed system with limited assimilative capacity (Geissdoerfer et al., 2017). Subsequently, the concept has evolved focusing on raw materials and resource flows, together with a plethora of notions based on closed loops (Geissdoerfer et al., 2017). In 2013, the Ellen MacArthur Foundation introduced CE as "an industrial economy that is restorative or regenerative by intention and design". Geissdoerfer et al. (2017) define the circular economy as "a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing and recycling". In addition, United Nations synthesize "circular economy as a system where products and services are traded in closed loops or cycles [...] with the aim to retain as much value as possible of products, parts, materials and resources" (UNECE, 2019). Similar is the definition given by the European Union as "an economy where the value of products, materials and resources is maintained in the economy for as long as possible and the generation of waste minimized" (Eurostat, 2019).

Currently, CE and its practical applications are absorbed in a multitude of different features of concepts sharing the idea of closed loops. Some of the most relevant influences are cradle-to-cradle (Braungart and McDonough, 2009), laws of ecology (Commoner, 1971), looped and performance economy (Stahel, 2010), regenerative design (Lyle, 1994), industrial ecology (Graedel and Allenby, 1995), biomimicry (Benyus, 2002) and the blue economy (Pauli, 2010). Recently a new application of circularity has been spreading in the urban environment. Many cities have formulated CE strategies within the last years (Prandeville et al., 2018; Paiho et al., 2020) even without a dedicated CE department desk in their municipality. Moreover, international organizations and agencies recognize the importance of development trends related to urbanization as fundamental to reach the Agenda 2030 goals (UNDESA, 2018), for example the European Investment Bank (EIB, 2018) defines circular a city that "conserves and reuses resources and products, share and increases use and minimizes resource consumption and wastage in all forms". According to the EMF's vision, "a circular city embeds the principles of CE across all its functions, establishing an urban system that is regenerative, accessible and abundant by practices circular economy principles to close resource loops, in partnership with the city's stakeholders (citizens, community and business), to realize its vision of a future-proof city" (EMF, 2017). On the other hand, Paiho (et al., 2020) affirms that CC "is based on closing, slowing and narrowing the resource loops as far as possible after the potential for conservation, efficiency improvements, resource sharing, and virtualization has been exhausted, with remaining needs for fresh material and energy being covered as far as possible based on local production using renewable natural resources". Therefore, a city becomes circular if practices CE rudiments to close resource loops, in partnership with the city's stakeholders (citizens, community, business and knowledge stakeholders), to realize its vision of a future - proof city (Prendeville et al., 2019). Moreover, the Circular Cities Hub of the Bartlett School of Planning, defines a circular city as based on system integration, flexibility, intelligence, cooperative behavior, localization, flexibility, intelligence, cooperative behaviour, localization, recycling and renewable resources (Paiho, 2020). They further add, "resources can be cycled between urban activities" and "cities can be designed so that land and infrastructure can be re-used/recycled over time." (Circular City Hub, 2017).

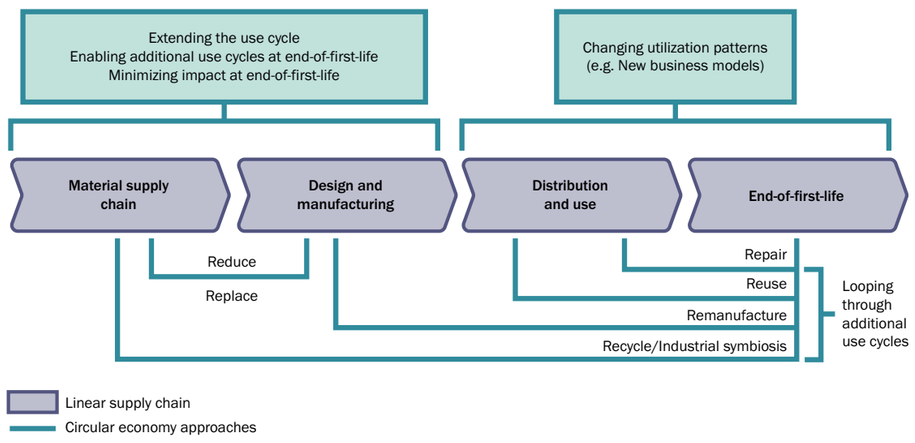
However, a proper definition of CC is unavailable. A circular city is a declaration of political and administrative intents, and the absence of spatial features makes it extremely complex to target circular indicators to define it (Paiho, 2020). One of the most relevant critique (Williams, 2019) refers to the difficulties in applying circularity from a theoretical concept (economy) to a practical one (urbanism), reason why policymakers and city planners find difficulties in putting in practice the notion of circularity. Organization like EMF drafts guidelines trying to overcome barriers between theory (economy) and practice (urbanism), such as 'Toolkit for Policymakers', outlining six policy intervention types and 'Circular economy in cities: project guide'. In its 'Vision for Europe' EMF (2015) uses an applied definition to urge Europe to transition towards CE with three key principles: preserve and enhance natural capital, optimize resource fields and foster system effectiveness. To underpin these, EMF describes six business actions that translate these three principles into concrete actions: Regenerate, Share, Optimize, Loop, Virtualize and Exchange (Prandeville et al., 2018). This descriptive yet practical framework focuses on CE activity on macro-level, from national, regional to city-level (Ghisellini et al., 2016). Another problem that complicates the application is the general difficulties on targeting what circular is: it is often mistaken with different concepts –. e.g., sustainable - or, in high-income cities, it is mainly used for referring to waste management activities.

03 A mandatory transition: from a Linear to a Circular Economy

Circular economy advocates a system emulating the biosphere cycle to contrast the current linear system “take-make-dispose”. In CE products are reused or repaired rather than thrown away, and the products are returned to the producer. It is a system in which waste from a process becomes an input into another process allowing resources to maintain their highest value possible. Hence, CE approaches could significantly reduce the need for extraction of primary resources and use of energy inputs (Figure 2).

The final objective of the new economy system is granting all countries equal access to resources, by decreasing the resource consumption of the richest countries. The concept is explained through the graph created by the economist Lemille (2019) (Figure 3). At present, the relation between the GDPs per capita of a country is directly proportional to the tons resources per capita, as represented in the GDP/tons per capita chart through the diagonal line. The objective of CE is to transform the diagonal line into a horizontal one, representing an equal resource consumption disregarding the GDP of the country. In the bottom part of the graph are placed African and Asian poorest countries (Niger, Bangladesh) followed by India. Moving forward along the regression line, the richest countries of Africa and Asia (Nigeria, South Africa, Egypt, Morocco, Colombia, China) and Brazil are found. Going up, the European countries, the US and Australia are the major consumers of resources.

Figure 2. Circular economy activities (Preston & Lehne, 2017)



The transition from linear to circular economy could reduce exposure to volatility in raw material prices (a large problem in developing countries) and increase economic productivity, together with generating more employment opportunities; at the same time, CE strategies could avert some of the major pressures developing countries are facing, with clear benefits in terms of lives saved as a result of reduced air, water and soil pollution (Preston & Lehne, 2017).

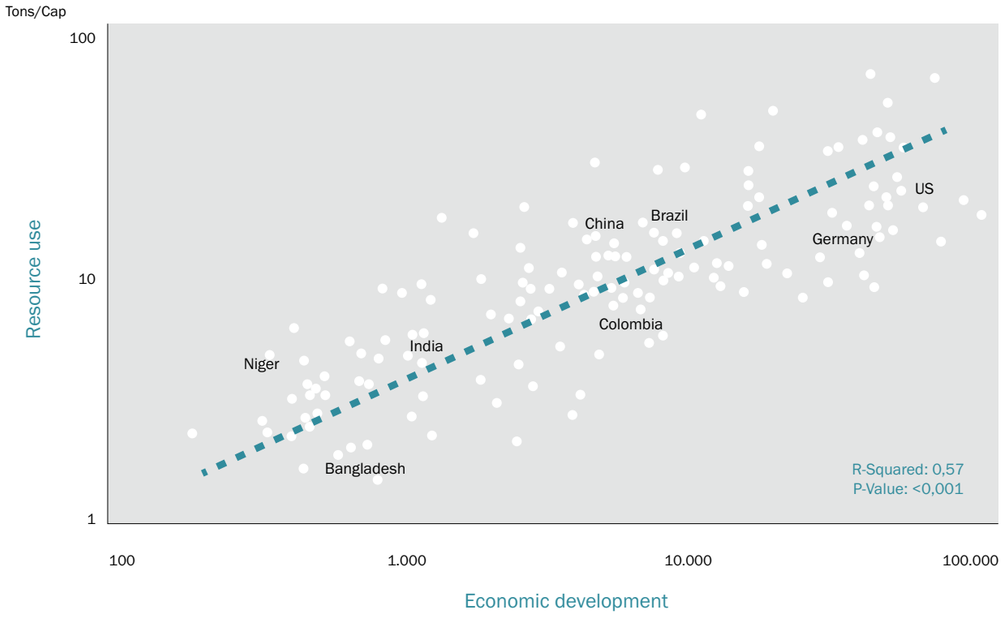
Uncontrolled extraction of raw materials destabilizes the financial market making the prices unstable, and their movements barely predictable. The uncertainty is caused by many changing factors, such as the population growth – new consumers of resources – and the African industrial revolution. Productivity can be implemented mostly with circular agricultural practices. Recycling nutrients and organic matter to reduce the use of synthetic fertilizers or practicing crop rotation and cover cropping that retain natural capital can play an important role in increasing yields for farmers. Introducing resource-efficient practices has led to improve the competitiveness of export-oriented sectors in developing countries (EIP-Agri 2015).

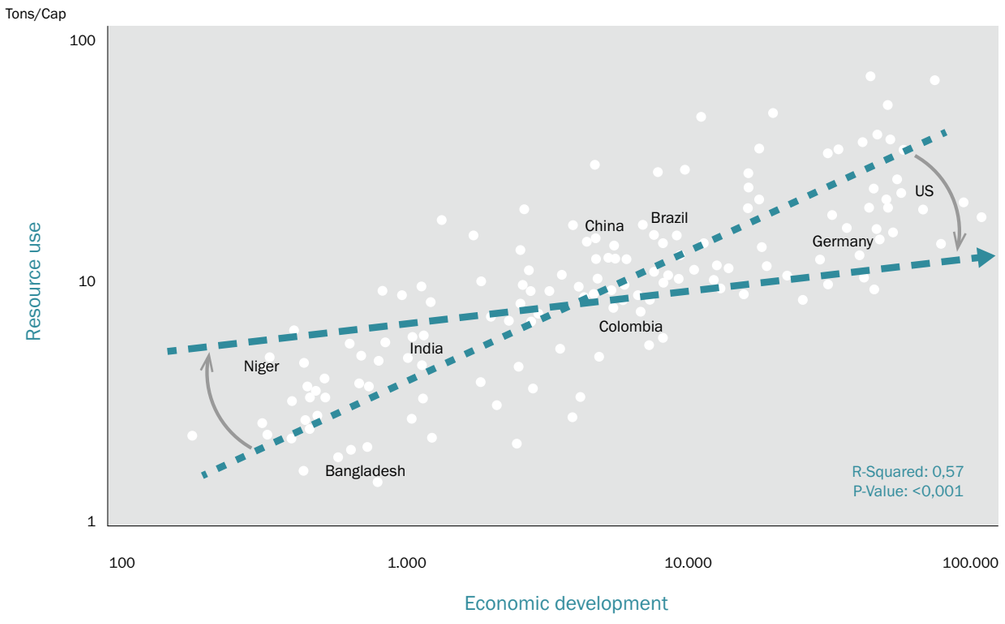
The employment potential of circular activities is already clear in many developing countries and have been clear even when the discussion was mostly focused on the purely green economy (UNEP, 2011). The remanufacturing and repair of products tend to require more labour than manufacturing from raw materials does, as deconstruction needs more workforce, resulting into more jobs.

Conversely, CE has been criticized due to the lack of trade-off risk recognition, circular approaches may be more energy-intensive or more costly than the alternatives. For example, CE could have negative impacts on employment in some heavy industries – the engine of the linear system –, and incumbent sectors might push to delay or weaken CE policy frameworks (Preston & Lehne, 2017). Thousand of people become unemployed and new circular jobs could take time. Careful approaches are needed to rapidly displacing employment in informal sectors, especially in low-income countries – in Sub-Saharan Africa the 55% of GDP activities are informal and employed the 80% of the workforce (UNECOSOC, 2015). This is one of the several barriers preventing the diffusion of CE. In addition, the implementation of CE has mainly focused on patch the large amount of waste production by recycling instead of reusing (Ghisellini et al., 2016), or restoring. To obtain it, it is necessary a bold change of heart and the decision-makers of the public and private sector have to be facilitators rather than financiers or simply promoters and it is necessary to implement the investments on circular activities.

Nowadays, CE is supported by a solid interest from academic literature with an increasing number of articles that concern specific areas as closed-loop value and supply chains, circular business model and circular product design (Geissdoerfer et al., 2017). Foundations and network societies are promoters of this new economic system, in particular the Ellen MacArthur Foundation, also acting as a collaborative hub for businesses, academia and policymakers (Geissdoerfer et al., 2017). Governments and intergovernmental agencies from local to interregional levels are beginning to implement circular actions. Germany was

Figure 3. The upper panel shows the relations between GDPs and resources consumption in the present linear economy system, while the lower panel shows the desirable change due to CE application. (Lemille, 2019)





a pioneer in 1996, with the enactment of the "Closed Substance Cycle and Waste Management Act" (Su et al., 2013). It has been followed by China's 2009 "Circular Economy Promotion Law of the People's Republic of China" (Lieder and Rashid, 2016), by the European Commission (2015) enact of the EU's 2015 Circular Economy Strategy and by Japan's 2020 "Basic Law for Establishing a Recycling-Based Society" (METI, 2016).
In Africa, the pioneer was Rwanda with the 2003 Environment Policy, and in 2008 plastic bags and packaging were forbidden. In 2016, the African Circular Economy Alliance (ACEA) was first conceived in collaboration with the Rwandan Ministry of Environment at the World Economic Forum on Africa. The year after, during a UN conference in Bonn, South Africa and Nigeria joined the alliance as co-chairs and ACEA was officially born. Nowadays, the member countries are ten from across the African continent, and the strategic partners include the African Development Bank, Africa Circular Economy Network, Global Environment Facility, Government of Finland, PACE, UN Environment, UN Development Programme and World Economic Forum The alliance is a country-led platform, that aims to lead advocacy projects, undertake policy research and support high-impact CE projects. The general objectives[3] of ACEA are sharing best practices, building partnership, financing the creation of CE projects, advocating for awareness of circularity from local to national level and bringing about new projects and partnerships in line with African Union "Agenda 2063". Indeed, in 2013 the African Union (AU) enacted the "Agenda 2063: The Africa We Want" a future perspective of inclusive growth and circular economy within a 50 year period from 2013 to 2063 (AU, 2013). The Agenda deals with realization by the countries leaders of a need of refocusing and reprioritising Africa's agenda from inclusive social and economic development, sustainability, democratic governance, peace and security. The Agenda is approved by all the 55 AU members. Moreover, also several municipalities are integrating their agenda with circular fundamentals: for example in September 2020, Cameroon created a parliamentary network to promote circular economy in Cameroon (PANCEC); its establishment is related to heavy floods during which poorly disposed-of waste blocked drainages (Bauer, 2020).
To conclude, the attention about the topic of circularity is rapidly increasing. During the last year several online meetings, webinars and reports have been organized: in September 2020, the African Development Bank and its partners hosted a webinar on the transition to a circular economy as part of Africa's post COVID-19 recovery; REVOLVE Circular and Circular Experience, two Vienna-based non-profit organisations, organized a live-stream in January that addressed the opportunities and challenges of the circular economy in Africa whit panelists from the African Development Bank Group, the Africa Circular Economy Research and Policy Network the African Circular Economy Network, and he Ministry of Industrialization, Trade and Enterprise Development in Kenya; after this event, the African Circular Economy Network (ACEN) planned the first pan-African Circular Economy Conference for 2022.

3 Reported from: https://pacecircular.org/african-circular-economy-alliance and https://www.weforum.org/our-impact/the-african-circular-economy-alliance-impact-story

04

Circular Economy in low and middle-income economies

The most relevant changes the Earth will face are going to occur in low and middle-income countries: the general growth and the low median age of the population make these countries the future home of most of the global working population. Therefore, CE in poorest countries does not deal exclusively with environmental sustainability, it is also an opportunity for job creation, resilient construction and economic growth – as emphasised in the South Africa President's speech at the UN 75th General Assembly as African Union Chair[4]. For example, according to the UN Environmental Protection Agency, 100,00 tonnes of used goods emptied in a landfill create six jobs, the same amount, if recycled, create 36 jobs, while reusing and repairing could create up to 296 jobs (UNEP, 2008).

Until recently, CE has been exclusively a rich-country agenda, it is often rooted in case studies and theories emerging from the global north and few studies have investigated the demand for CE actions among stakeholders of backward economies (Preston & Lehne, 2017). However, despite few papers and research to prove it, circularity exists in the poorest countries and, in some fields, it is spreader than in the richer counterparts.

In Africa, for example, the concept is still not well defined and, although case studies exist, they have remained largely hidden (Desmond and Asamba, 2019). Indeed, more 'circular' behaviour is often raised from economic difficulties. The lack of resources induces reusing and recycling together with avoiding waste, and may facilitate the shift towards a CE, making it more intuitive in countries where a higher share of economic activity revolves around repairing and reusing or sorting waste. Additionally, African urban sustainability is already contributing to principles now associated with the circular economy. The transition to circularity may request less of changes in everyday actions due to the everyday practice socially accepted.

Conversely, the advanced economies are locked into existing resource-intensive industrial systems and infrastructure. Despite the increasing awareness among the consumers and the high rates of recycling of local administration, there are additional steps to achieve in order to extinguish prejudices against CE and resource preservation practices (De Jong et al., 2016). The imaginaries of success have to be reshaped away from overconsumption. The "take-make-dispose" model need to be substituted with the goal of sustainability and circularity. It is important to assist the transition of poor communities towards circularity, skipping the linear system passage.

4 Speech reported at: https://www.youtube.com/watch?v=fSqLeN8oc3k

Notably, low and middle-income economies have to learn from the CE lessons experienced in the rest of the world, particularly the case of the EU and China, creating its own circular practices and avoiding impositions from outside. If developing countries were expected to simply follow in the footsteps of developed economies, the CE would be decades away. (Preston & Lehne, 2017). Besides, transfer best practices may lead to suboptimal solutions particularly when the imported practices concern complex phenomena, involving networks of multiple actors and relying on place-specific dynamics (Varjú et al., 2019). Fortunately, this is an agenda on which countries can forge their own paths, considering the peculiar characteristics of the interested place, and supported through cooperation with other countries. There are many key areas – such as e-commerce, off-grid renewable energy or urban agriculture – where low and middle-income countries are leader, rather than follower of the richer counterparts. Indeed, transplanting circular economy theories into different contexts from which the idea has born, requires a holistic approach which integrates economic, social and environmental sustainability dimensions, including generating new knowledge, policies and actions.

For low and middle-income economies, a large step forward consists in enhance robust top-down policies to regularize industrial and productive sectors. As already mentioned , it is essential to persuade the leaders of backward economies that CE approaches can unlock new opportunities for industrialization and accelerate efforts to create solutions to other critical development challenges. Revolution in the industrial sector is fundamental because, despite ongoing advancements, the principal model of industrialization has remained largely unchanged, as it was – and still is – characterized by linear consumption (De Jong, et al., 2016). All these initiatives of circularity could develop into a powerful umbrella term, helping to build political momentum around a set of ideas that can be applied in and tailored to multiple sectors or cities (Preston & Lehne, 2017).

For all these reasons, circular economy initiatives have to move from small private projects, or waste management processes, to networks and government entities to promote and support CE implementation and regulation. Moreover, circularity strategies find it tougher testing ground in cities: urban areas can contribute to address community-wide environmental, health and economic objectives in a multi-stakeholder-based way. In particular, African cities cannot be left out in the circular economy transition.

05

African Urban Circular Economy (factors and indicators)

As abovementioned, cities are the living laboratories of changes we are facing within the following years and will play a key role in reducing humankind's footprint on the planet Earth.

The spreading of urbanisation leads to an increase in the global natural resources and the global energy supply consumption, together with a consequent growth of waste and emissions production. In 2016, cities with at least 1 million inhabitants were 512 and megacities (up to 10 million inhabitants) 31. In 2030 these numbers will increase up to 662 1 million cities and 41 megacities (Preston & Lehne, 2017). Moreover, 80% of cities in 2014 are located in vulnerable areas, facing higher risks of mortality or economic losses associated with natural disasters or other environmental challenges (UNECE, 2019). The highly congested physical spaces characterizing urban territories are prone to various other challenges such as population increase, urban sprawl, environmental degradation and fiscal pressures. Furthermore, the current consumption levels in cities exceed their economic capacity and biocapacity, ultimately affecting the well-being of all city dwellers.

In Africa, density trends and urban and city growth are faster than anywhere else. African cities are dynamic and at their early stages of urban development and industrialization: planning them means considering double the present population, which will be reached in ten years (OECD, 2020). As stated in the previous chapter, circularity not only involves sustainable development, but also fair economic, social and progress. Circular measures could facilitate the gradual and logical expansion of neighbourhoods together with the implementation of facilities; the measures suggest a new way of managing the relationship between markets, costumers and natural resources, avoiding waste and equally redistributing services. City assets and products can all be considered as potential inputs for circular actions.

A common critique to the circular city concept (Williams, 2019) is the difficulty in applying theoretical principles of the circular economy to a practical and solid context, such as built-up areas. Indeed, the definitions given by the experts (academics or international organizations) remain on general assumptions: “a circular city embeds the principles of a circular economy across all its functions, establishing an urban system that is regenerative, accessible and abundant by practices circular economy principles to close resource loops, in partnership with the city’s stakeholders (citizens, community and business), to realize its vision of a future-proof city” (EMF, 2017). The EMF’s definition is one of the most validated and quoted, despite not being an exhaustive explanation for decision-makers who should promote urban circularity.

The lack of specific definitions is given by the difficulty in targeting what circularity is in cities and in finding case studies as a unique model to suggest. The problem of the CC concept is the complexity in detailing measures to apply concretely its principles to the urban context. As being a declaration of intent, CC states what to aim for not mentioning how to achieve it. Paiho et al. (2020) affirm that “as with the definition of circular economy in general, no single definition of what constitutes a circular city currently exists”. Each city is a complex system that consists of differences, it is hard to compare CE principles enforced in different contexts and it is not possible to define which policy decision is most relevant (Prendeville et al., 2018). Therefore, both public and business actors lack clarity on how to apply circular economy in cities: “This ambiguity makes it difficult for policymakers to apply CE in day-to-day activities and work against the cities progress towards circularity” (Paiho et al., 2020). This unclarity can be a limit in fostering the CC model.

The first problem is to understand the intervention area; considering the whole urban area results in including many different realities, difficult to gather under same strategy. Besides, CE works better in delimited areas where it is easier to close loops; a starting point is individuating communities, neighbourhoods, or blocks that share commonalities, to select the range of CE application. Creating a hierarchical organization reduces the risk of losing the overall framework.

After the definition of an intervention area, the strategy focuses on selecting flows that cross the city - concept taken from the urban metabolism - (for example water, waste, energy, mobility etc.), and on selecting which top-down or bottom-up approach to use. Moreover, the kind of intervention can be defined through the selected CE action (EMF’s system of ReSOLVE), the established final targets to achieve (SDG’s of the Agenda 2030) and the respect of peculiar considerations to contextualize the intervention in a certain area.

The resource loops are urban fluxes studied by the branch of urban metabolism, a way older concept that exists since the 1960s. The flows are the sum total of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste. This concept is used as a metaphor to define the city as a living organism, it describes and quantifies the main flows that enter in a city, which are used or stored, and then that leaves that city, thus offering an integrated and holistic view of all the city’s activities, of its levels of resource productivity (gross domestic production/domestic material consumption) and urban systems’ efficiency and sustainability. Urban metabolism is a model facilitating the city inclusion into a circular vision and a tool for accelerating the transition and assessing circularity.

In circular cities, any stakeholder has any of the three following roles: an enabler, a content provider, or a user (Paiho et al., 2020). The application and the success of pursuing circularity must arrive from every level of city user; for this reason, a general combined top-down (national efforts at societal, legislative and policy levels) and bottom-up approach (company and community collaborations, supply chain efforts, product design, information and communication technology) is required (Lieder and Rashid, 2016). The single

intervention can be approached choosing among the two.

The ReSOLVE framework (Figure 4) consists in six action areas developed by the Ellen MacArthur Foundation to support the transition to a circular economy. Regenerate, Share, Optimise, Loop, Virtualise and Exchange are practices for who aim at moving towards the CE, businesses, countries, or communities.

Circular economy practices are crucial to achieve the Sustainable Development Goals of Agenda 2030, many of the topics touched upon the SDGs are largely displayed in urban areas. As a matter of facts, the Goals 11 deals with “sustainable cities and communities: making cities inclusive, safe, resilient and sustainable”, themes included in the urban circularity vision.

In general, the CE underpins efforts material poverty by shielding growth from the upward trend in resource prices and volatility (Goal 12), by promoting a sustainable economic growth and decent works (Goal 8) that ensure healthier lives (Goal 3) and by revitalizing the global partnership for sustainable development (Goal 17). The CE indirectly contributes to reduce the inequalities among countries (Goal 10), by redistributing the access to global resources and aims to mitigate and combat climate change impacts (Goal 13).

In particular, in cities of low and middle-income economies, circularity is linked with the enhancement of the access to water and sanitation (Goal 6) and the access to affordable, reliable and sustainable energy; moreover, CC aims to build resilient infrastructure and foster innovation (Goal 9), increasing the number of citizens with relevant working skills (Goal 8 and 4). Those targets bring the urban area to ensure healty life and promote well-being (Goal 3) or inclusive societies (Goal 16) and again a bold support in fighting climate change (Goal 13). In figure 5 a summary is outlined.

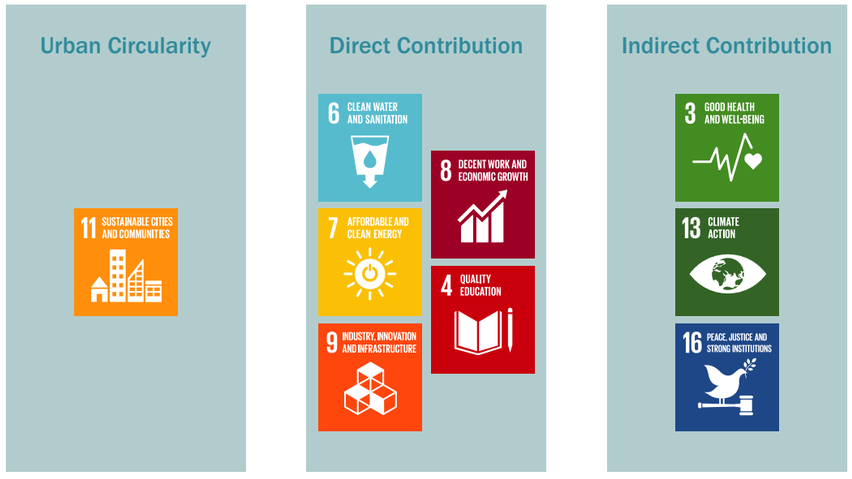
Figure 4. SOURCE: Ellen MacArthur Foundation, SUN and McKinsey Center for Business and Environment, Growth Within: A Circular Economy Vision for a Competitive Europe (2015). Based on S. Heck, M. Rogers, P. Carroll, Resource Revolution (2015).

REGENERATE	Shift to renewable energy and materials Reclaim, retain, and restore health of ecosystems Return recovered biological resources to the biosphere
SHARE	Share assets (es cars, rooms, appliances) Reuse/secondhand Prolong life through maintenanace, design for durability, upgradability etc
OPTIMISE	Increase performance/efficiency of product Remove waste in production and supply chain Leverage big data, automation, remote sensing and steering
LOOP	Remanufactoring products or components Recycle materials Digest anaerobically Extract biochemicals from organic waste
VIRTUALIZE	Dematerialise directly (es books, CDs, DVDs, travel) Dematerialise indirectly (es online shopping)
EXCHANGE	Replace old with advenced non-renewable materials Aply new technologies (es 3D printing) Choose new product/service (es multimodal transport)

The debate[5] on the opportunities of circularity in Africa is just begun, and six key considerations for African contexts have been proposed to accompany the set of circular principles and strategies. The considerations resume some of the aforementioned topics:

- Approaching urban circularity in Africa is to acknowledge and support existing practices. Indeed, many African communities have local and traditional sustainable practices, valid examples to contribute to ecological regeneration, sharing and maintenance of material or service value.
- CE principles are implemented within a social justice framework. That implies the awareness of the typology and number of jobs created and lost due to circularity initiatives, and the stakeholders who benefit from the initiative to avoid inequalities in compensations and opportunities.
- The alignment with the Governance frameworks of their context. This is both to ensure that the circular economy initiatives are contributing to strategic objectives set out by national and local government, but also that local and the national governments are sufficiently aware and engaged in developing enabling environments within which circularity initiatives can be most effective.
- Improving access to finance for circular development, circularity needs financers rather than promoters (how it has been so far).
- Investing in natural regeneration; to invert

Figure 5. Urban circularity, direct and indirect contributions to SDGs



5 Realising opportunities for the Circular Economy in African cities, online event held on 25th November 2020 by ICLEI and ACEN. Available at: https://www.acen.africa/circularity-in-african-cities

current trends takes time, planning the regeneration process will accomplish the target faster.

- Spreading and sharing the acquired knowledge on circularity. The suggestion is to collaborate and promote co-learning between cities, decision and policymakers and stakeholders of different countries.

Developing from the latest consideration, this report aims to propose a method to classify the existing examples.

06 Case Studies in Sub-Saharan Africa

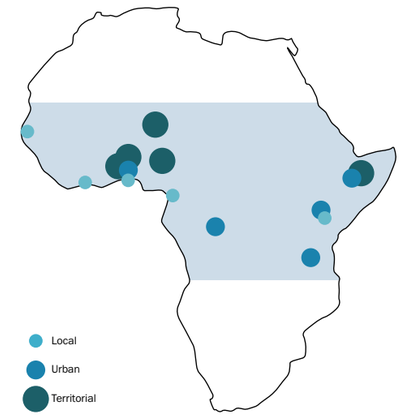
The case studies analysed in this paper are selected from several countries of the Sub-Saharan region (Figure 6 shows the localization and the impact of each case) to illustrate different backgrounds and experiences. In particular, this area has been selected due to the high concentration of poverty in it: over 70 percent of the global poorest are concentrated in 10 countries and most of them are in this geographical area – Nigeria, D.R. Congo, Ethiopia, Tanzania, Kenya, Madagascar, Kenya, Mozambique, Uganda, and Malawi[6].

Southern Africa area has been consciously not considered due to the influence of South Africa, a country with different political and social dynamics, already considerably advanced in sustainability and circular achievements.

Indeed most of the available information on African circular activities comes from the south area, while the circular activities from the central one are less known and the work wants to stress these virtuous initiatives.

Having a categorisation of the existing case studies helps to share circular initiatives among different countries which want to undertake the circular transition. Through the abovementioned factors, it is possible to characterize and define each case study to facilitate the transfer to new realities and pursue urban circularity. Moreover, a catalogue sheds light on common barriers and identifies elements of best practice. Far from being unique situations, these examples show the potentialities of each country.

Figure 6. Case studies localization and scale typology



6 Data reported at https://blogs.worldbank.org/opendata/here-are-top-10-sub-saharan-african-countries-have-reduced-poverty-most

Table 1 catalogues the case studies below descripted to ease the comparison and visualization of the strategy adopted and the actions required to implement the example, or the targets pursued. The selected examples are arranged into a matrix outline, where in the first-row the case studies are divided following their scale dimensions: **local** as neighbourhood area, urban as municipality area and **territorial** as national or countryside area; in the first column they are divided into five selected urban flows that usually cross the city (mobility, food, waste, energy, water). In low and middle-income cities **mobility** is a huge and complex flow due to the dislocation of the working places often far away from the dormitory areas; the non egalitarian, and sometime scarce, accessibility to food supplies makes **food** another important urban flow; the flow of **waste** needs attention also due to the practice of richer countries to sell their waste to poorest countries, amount which adds to the local production; **energy** and **water** facilities do not always cover the needs, often they are completely absent, and it is fundamental to develop practices to restore, save and expand these resources. Therefore, each proposed example is labeled with the strategy typology adopted: **top-down** related to national efforts at societal, legislative and policy levels, or **bottom-up** where company and community collaborate on supply chain efforts, product design, information and communication technology. To underline which kind of actions are implemented by the case studios to pursue circularity, the table includes the ReSOLVE actions, the model defined by the Ellen MacArthur Foundation already mentioned: **Regenerate**, **Share**, **Optimize**, **Loop**, **Virtualize** and **Exchange** are the input actions. Finally, each case studio is tagged by the **SDGs** target pursued. The SDGs are tools that aim to facilitate the individualization, their definition and the accomplishment of the final objectives. The Goal 11 about Sustainable Cities and Communities is a common target of many of the described examples, but it is always supported with others goals that can have both a direct or an indirect contributions (for example the Goal 8 of decent work is a direct contributor, the Goal 13 about climate action is am indirect one).

Table 1. Examples of circular approaches labelled by strategy, actions and final targets. Sources: Author's own analysis

TABLE 1	LOCAL	URBAN	LANDSCAPE
Mobility	SUMP Sustainable, Urban Mobility Plan (Ruiru, Kiambu, Kenya) 11 9 3 13	MSP Megenagna Smart Parking (Addis Ababa, Ethiopia) 11 9 3 13 8	LRT Light-Rail Train (Ethiopia) 9 7 8 3
Food	Micro-Gardening (Municipalities of Dakar, Senegal) 11 4 3 13	Micro-Gardening (Municipalities of Dakar, Senegal) 11 4 8 7 6	AgroBootCamp (Benin) 8 4 16
Waste	Coliba (Abidjan, Ivory Coast) 11 6 8 3	Eco Bricks (Livingston, Zambia) 11 6 8 13	NAMé recycling (Cameroon and Gabon) 11 8 13
Energy	SOLARLIFE (Douala, Cameroon) 7 6 13 3	Umoja estate (ANairobi, Kenya) 7 9 13 11	Benoo (Togo) 7 8 13
Water	Triton (Cotonou, Benin) 11 7 8 13	Pure Water Tech (DCR) 6 7 8 9	Tech-innov (Niger) 13 7 8

Strategy

- Bottom-up
- Top down

Actions

- Regenerate
- Share
- Optimise
- Loop
- Virtualise
- Exchange

SDG Targets

- 3 GOOD HEALTH AND WELL-BEING
- 4 QUALITY EDUCATION
- 6 CLEAN WATER AND SANITATION
- 7 AFFORDABLE AND CLEAN ENERGY
- 8 DECENT WORK AND ECONOMY GROWTH
- 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
- 11 SUSTAINABLE CITIES AND COMMUNIITES
- 13 CLIMATE ACTION
- 16 PEACE, JUSTICE AND STRONG INSTITUTIONS

For better understanding the following selection, case studies are assembled by five urban flows: Mobility, Food, Waste, Energy and Water.

Mobility

The mobility flow represents the physical movement that crosses the city and that permits urban activities. In this area, the mobility fluxes are intense, highly polluting and destined to increase. The following examples show how the adoption of circular actions (optimization, virtualization or energy regeneration) in specific infrastructures can improve mobility services and the quality of life.

SUMP - Sustainable Urban Mobility Plan (Ruiru, Kiambu, Kenya)[7]

The town of Ruiru in Kiambu country (Kenya) is developing a "Sustainable Urban Mobility Plan". Through a collaboration with the University of Nairobi and UN-Habitat. The SUMP's main idea is to engage all stakeholders, including government, local businesses and residents in participatory workshops to implement walking and cycling facilities together with the overall objective of making the town accessible for all. The proposed modification will incorporate better walking facilities, safer pedestrian crossings and space for attractive and better managed street vending that will encourage local economic activities (Figure 7). Besides the reorganization of traffic flows and parking spaces, as well as the incorporation of large sidewalks and the preservation of trees and bushes, the proposal includes the transformation of selected streets into pedestrianized zones. The main characteristics of these areas include the absence of cars to allow the appropriation of the streets by pedestrians, a larger green canopy, designated spaces for street vendors, well-designed pavements to create a signature look for the streets, as well as large, pleasant resting areas such as parklets or benches for seating.

MSP – Megenagna Smart Parking (Addis Ababa, Ethiopia)[8]

To solve the space parking problem, Addis Ababa's Transport Programs Management Office (TPMO) is developing the pilot project of "Megenagna Smart Parking" as an instrument to reduce GHG emissions, improve air quality and reduce traffic jams. Equipped with modern devices, such as cameras and sensors, MSP is the first smart parking facility constructed within this new city's mobility management plan 2017-2027 – the master plan embeds the construction of 60 parking areas. The MSP connects six road junctures convening from different parts of the capital, and its aim is to alleviate the pressure on the surrounding road network and traffic flow issues in the area by providing more parking slots. Moreover, it contributes to GHG emissions reduction and air quality improvement by alleviating traffic congestion, through reducing time drivers need to find a free parking space and it presented a job opportunity for 20 people, becoming the leading example for other smart parking systems being built across the city.

7 UN Habitat. (2018). Energy and resource efficient urban neighbourhood design principles for tropical countries, 188-189.

8 C40 Cities case studies. Available at: https://www.c40.org/case_studies/addis-ababa-s-megenagna-smart-parking-as-an-instrument-to-reduce-ghg-emissions-improve-air-quality-and-reduce-traffic-jams.
AACPPO. Addis Ababa City Structure Plan, Draft final summary report (2017-2027). Available at: https://c40-production-images.s3.amazonaws.com/other_uploads/images/2036_Addis_Ababa_Structural_Plan_2017_to_2027.original.pdf?1544193458

LRT – Light-Rail Train (Ethiopia)[9]

Addis Ababa inaugurated the first light-rail train (LRT), an inner-city tram powered by Ethiopia's power grid, which is fueled almost exclusively by hydroelectric, geothermal and wind energy. Emissions reductions from the project are estimated to grow from 55,000 tons of CO2 per year in 2015 to 170.000 tons C02 per year by 2030. The renewable energy-powered LRT reduces greenhouses gas emissions while bringing clean and efficient transportation to city dwellers. The expected reduction of traffic flows and particulate emissions will significantly reduce the commuting time of workers in the city and the incidence of heart and respiratory diseases. Moreover, the construction of the infrastructure creates more jobs, stimulates the local economy and attract new investments. The project is an international multi-stakeholder collaboration between the Ethiopian government, foreign banks and the Chinese government.

Food

Circularity principles can have a positive impact on improving food insecurity, in particular in saving agricultural resources such as water, energy and land (in dense urban areas cultivable land often lacks).

Micro-Gardening (Municipalities of the city of Dakar, Senegal)[10]

As several African capital city, Dakar is experiencing unprecedented population growth, due to rural-urban migration. The urbanization process has also reduced the availability of arable land, already compromised by the effects of climate change. This has caused a general increase in the price of vegetables and further puts at risk the food security of the most vulnerable strata of population. For this reason, the Municipality of Dakar implemented a project in support of micro-gardening with the double aim of addressing food insecurity, while contributing to social stability. Overview of the food practice Micro-gardening consists of gardening on standing tables. The micro-garden uses recycled materials as supports (wooden pallets, tires, buckets, old vases and bottles). The soil substrate is composed of peanut shells and rice straw, recycled waste. The project covers the entire city of Dakar (19 municipalities), offers trainings in micro-gardening techniques and provides space dedicated for gardens within public spaces (e.g. schools). The micro-garden technique requires inexpensive technology and little physical effort, which further enhances the inclusion of vulnerable groups, such as women, young people, the elderly and the disabled or inmates of remand homes and prisons.

The co-benefits are many, the practice of micro-gardening uses very little water and contributes to the greening of the capital, which in turn reduces greenhouse gases; it is also a learning space, where children develop sustainable and eco-friendly behaviours; it needs very little space, and it can be replicated and implemented almost anywhere, in the courtyards of houses or schools, in public spaces, etc.

Promoted by FAO, University of Milan, the city of Dakar and NGO ACRA, the micro-garden model is in this way an example of circularity (recycling and reusing waste), it has a high potential for replication, representing a valuable initiative to

9 C40. (2016). Cities 100, 2, 127. Available at: https://issuu.com/sustainia/docs/cities100_2016_final_small

10 http://www.fao.org/3/ca0493en/CA0493EN.pdf

tackle climate change and food insecurity.

Songhaï (Porto-Novo, Benin)[11]
Located into the Porto-Novo banlieue (capital city of Benin), Songhaï is a urban farm born in 1985. With its agricultural fields, pisciculture and livestock the farm is an extraordinary example of agriculture entrepreneurship. Today, Songhaï has been held by the United Nations as a center of excellence of the social commitment to provide education and work opportunities for young people. The educational activities through a functional training based on knowledge, skills and a value system is also recognized by the UNESCO. Here, all the activities scraps are inputs for new ones. The center promotes a bio-production with natural fertilizers derived from organic materials (RCW Ramial Chipped Wood). To maximize the value of the products, the farm processes the agricultural productions with simple and natural technologies (to obtain secondary products, such as palm or kernel oil, fruit juice, feed for animals and livestock). All the plant and animal wastes are potential organic energy (biogas), and together with solar and wind energy, the center it is planning to expand the "Shongaï energy project". The center aims also to train (Shongaï Leadership Academy) a new leadership able to manage a rural development and to promote a sustainable socio-economic entrepreneurship policy.

Currently, the Songhai model of green rural cities extends beyond the capital city of Porto Novo, there are other sites in agro-ecological zones to produce. Therefore, the model has also been exported, it has started replication in other countries in the region, such as Nigeria, Liberia, Sierra Leone and Congo-Brazzaville.

AgroBootCamp (Benin)[12]
The project of AgroBootCamp is born in 2018 by a collective of Beninese, Togolese and French enterprises and associations to empower young Africans through activities that both generate income and respect of the environment. In general, farm working is still considered degrading and it is mostly underpaid, the camp aims also to demolish the stigma. AgroBootCamp is a 7days of practical and field training in agroecology and green entrepreneurship. The program is divided into workshop on environmental friendly agriculture, eco-activity workshop and entrepreneurship initiation workshops. After the camp week, the organization keeps supporting the new entrepreneurs at least for six months. Today, the camp is at the fourth edition and participants come from Togo, Burkina Faso, Côte d'Ivoire, Mali, Guinea, Niger, Congo Brazzaville, Cameroon, Martinique and Benin.

Waste

The flow of waste is the most related to the general concept of circularity, indeed it is important to underline as the objective of circularity is to limit (until eliminate) waste production. Even if waste remains an urgent problem, in some areas of the world more than others, and circular approaches can facilitate its creative collection and disposal.

Coliba (Abidjan, Ivory Coast)[13]
In Ivory Coast, the start-up Coliba collects plastic garbage from the streets of Abidjan thanks to mobile supports. Recycling plastic waste is a promising sector in Africa, the objective is to employ and train young people in these emerging jobs: each member becomes a coordinator, an operator or a collector. The employees of the company are mainly people more exposed to poverty (women above all). Clearing streets from plastic waste it is important to limit health risks associated with the degradation of plastic, the water stagnation and the consequent proliferation of mosquitos. The waste collector program works through a platform. To report a pile of garbage to be collected, the user opens the app which geolocated the area and the company sends a collector to pick up the pile. In exchange, the user receives points that turn into phone credit, Internet connection data, events ticket or school kits. Then, the collected waste is sold to those industries that are able to re-integrate the plastic in their production frameworks. The Ivorian recycling market has a high value estimation of 120 billion CFA franc (180 million euros), and it could employ more than 100,000 people (according to the Agence Nationale de Salubrité Urbaine, ANASUR). The project wants to expand through all the 10 municipalities of Abidjan and move to other big cities of West Africa.

EcoBricks (Livingston, Zambia)[14]
The idea of EcoBricks is born in Guatemala few years ago and Zambia (together with South Africa) is the African country that uses this construction technology to build. The African Impact Foundation is an ONG that promotes independency of fragile communities providing tools and expertise. One of the projects of the foundation is to increase the know-how of the Ecobricks. An Ecobrick is a PET bottle packed solid with clean and dry used plastic, it is a low-tech solution that does not need for machines, special skills or capitals. The main objectives are to create reusable building blocks (without producing new ones) and to collect plastic waste. Indeed, the consumed plastic is sequestered and contained it safely, by terminally reducing the net surface area of the packed plastic to effectively secure the plastic from degrading into toxins and microplastics. Ecobricks can be used to build furniture (benches for schools for example), garden walls, compost bin, chicken coop and piggery fence.

NAMé recycling (Cameroon and Gabon)[15]
The NAMé company aims to give plastic waste a second life through recycling. The project started in Limbè, a city of Comeroon, as a service of plastic collector. Nowadays, NAMé is operating 3 plants in Cameroon and Gabon, the bottles collected are 70 million and the reduction of CO_2 emissions is about 5 millions kg. The process starts with the collection of plastic waste by independent pickers from individual households, from the street and from municipal collection centers. The delivered quantities are paid for in cash based on the weight and the quality of waste. The waste is sorted into PET, HDPE and LDPE plastics, to treat each type accordingly. Then the plastic waste needs to be washed thoroughly to remove impurities such as labels, adhesives, fluids, sand, dust and dirt. This is to enhance the quality of the finished product. After washing, the waste is loaded onto conveyor belts and led to shredders where the plastics are reduced to flakes. The shredders tear up

11 http://www.songhai.org/
12 http://blog.djouman.com/fr/agrobootcamp-bilan-positif-pour-4e-edition.html
13 https://coliba.ci/
14 https://africanimpact.com/volunteer/environmental-conservation-ecobricking-zambia/, https://www.ecobricks.org/
15 https://www.name-recycling.com

the plastic into small flakes, preparing them for recycling into other products. These flakes are then exported to various international markets especially in Europe to be transformed into various new plastic products. Thus, completing the material loop from bottle to bottle.

Energy

The flow of energy affects different activities in urban and extra-urban areas, but the infrastructures are still not able to cover most of the inhabited territories (particularly in isolated villages). Circular frameworks can supply the absence of national infrastructures, providing sustainable, clean energy.

SOLARLIFE (Douala, Cameroon)[16]

Based in Douala, a city of Cameroon, the start-up SOLARLIFE distributes solar cooking kits by microcredit. The employees of the company are trained and motivated to educate and advise customers on solar energy and energy efficiency. Indeed, the kits are rechargeable with solar panels and provides access to electricity: it gives the possibility of recharging electronic devices while it is not used to cook. This kit is particularly useful in those areas not covered by the national electric framework, places isolated and far from the urban centers. Together with an affordable cost, the solar kit decries the consumption of firewood or charcoal for cooking, avoiding risks of respiratory diseases, and it lightens the electric system that often goes out.

Umoja estate (Nairobi, Kenya)[17]

In Kenya, the Government advocates a project to empower local communities in the waste management chain. In particular, in Nairobi half oh the population lives in informal settlements where there is a lack of organized solid waste management systems, due to poor accessibility and lack of infrastructures. The pilot project promoted by the municipality is in a biogas plant in Umoja estate that aims to turn organic waste into energy biogas. This is possible because in Nairobi more than 50% of waste production (2,400 tons daily) is organic. The biogas power plant will be fed with food waste from surrounding estates, and it will also use animal waste, such as cow dung. The plant will be able to capture, collect and process biogas for domestic use. The gas will be distributed among 5,000 local households and to nearby restaurants. This project is foreseen to positively impact the local residents' economy and leave the surroundings cleaner, together with a significantly reduction of the city's GHG and CO_2 emissions.

Benoo (Togo)[18]

Benoo Energies brings energy facilities into rural areas of Togo. The start-up aims to promote access to sustainable energy, develops and markets solar energy recovery units for rural entrepreneurs. A solar kiosk called "energy agencies" sells services and helps new entrepreneurs in their activities. The concept of the company is based on three steps: first, a connected solar kiosk to sell services to the village where it is installed; then, a rural entrepreneur of the energy agency equipped with a mobile application to manage and sustain his activity; lastly, the collection and analysis of all the data to provide decision and support tools for larger scale rural electrification projects. The business model has it peculiarities considering that the user can either rent or buy the development tool and the payments are calculated according to the turnover generated. One of the final targets of Benoo is the creation of a new profession for African rural areas, which is a profitable lever for socio-economic development.

Water

Water is a good that has to be preserved, and applying circularity principles to these flows will reduce the dispersion through virtualization and technologies.

Triton (Cotonou, Benin)[19]

The Triton is a mobile washing tricycle that moves where the cars are parked in the streets of Cotonou (Benin). The project is changing the habits of motorists by coming to them to wash their cars, letting to the costumers to save time and water. Indeed, the Triton uses less than 30 liters of water for a car, it is an enormous water saving compared to the 75 or even 100 liters of water used in conventional washing centers. Moreover, as the tricycle drives to costumers, it generates energy which is stored to then run the water pump and vacuum cleaner used during the operation. The washing service saves more than half of the water used in the traditional carwash and the power needed is produced by cycling. The soap used to wash cars is biodegradable and made from agricultural product residues.

Pure Water Tech (DCR)[20]

The Pure Water Tech project enhances the penurity of water in African continent, 1 out of 3 people globally do not have access to safe drinking water and 40% of these lives in Sub-Saharan Africa (WHO, 2019). Then the water demand will increase and to supply it will be necessary large investments. The device responds to this huge problem with sophisticated technology: it extracts water from the humidity in the air, thanks to the high temperature and the high level of humidity of central Africa. The product can be connected to a solar panel for its autonomy and used in private or public buildings of cities or in isolated areas.

Tech-innov (Niger)[21]

In Niger, the Tech-innov social enterprise has developed a remote-controlled tele-irrigation system to improve water management. The project allows farmers to activate watering on their farms from anywhere. The technological process also makes it possible to collect and disseminate meteorological and hydrological data in real time: temperature, soil moisture level, rainfall, solar radiation and wind speed. The farmer has all the information to meet the water needs of his fields. The users can save time and energy to reinvest in other activities of their business. The system allows them to increase the irrigable area, increase production, increase their income and control water consumption. This contributes to the reduction of poverty but also to the reduction of greenhouse gases by the substitution of thermal energy with renewable energy.

16 http://blog.djouman.com/fr/mur-d-inspiration/solarlife-la-cuisine-se-met-aux-energies-propres.html
17 https://www.c40.org/case_studies/umoja-estate-nairobi-turns-organic-waste-into-clean-energy-biogas
18 https://www.benoo-energies.com/
19 http://blog.djouman.com/fr/triton-lavage-automobile-ecologique-afrique.html
20 http://blog.djouman.com/fr/the-pure-water-tech-technologie-de-pointe-lh20-dafrique.html
21 http://blog.djouman.com/fr/mur-d-inspiration/niger-lirrigation-geree-a-distance-telephone-portable.html

07 Conclusions

The first alarm on climate change had been declared more than 40 years ago. Today, despite the general awareness about the issue and the new opportunities, few considerable results had been achieved. In particular, between the six critical steps that decision-makers must pay attention on tackle mitigation of climate change effects, the most relevant two are frequently set aside: economic and population growth. These phenomena are increasing and are the major cause of GHG and CO_2 emissions, raw material consumption and waste production. Notably in urban settlements of the low and middle-income countries, where the trends are wider and faster.

The spread of the COVID-19 pandemic has caused a shrinking of the global ecological footprint, demonstrating how rapid changes in the consumption patterns of natural resources are possible. The concept of circular economy offers the bold changeover that could drive society into a more sustainable way of life: from the linear ‘take, make, dispose’ economy to a ‘cradle to cradle’ system.

This work has tried to clarify what is the circular economy system and how it is applied in the urban environment. Moreover, the report investigated if it is possible to deal with CE in low and middle-income countries (focusing on the African continent), which are the trends and if there are related case studios. The circular economy has been a rich-country agenda for several years, and even today it is still difficult to find literature or examples not concerning these countries. Nonetheless, in low and middle-income countries recycle and sustainability are current practices even not reported or planned: the shift towards a CE is possible and might be more ‘intuitive’ without a large upheaval, because a higher share of economic activity revolves around repairing, reusing or sorting waste. Poorest countries are in many ways more ‘circular’ than their richer counterparts, but it is necessary an agenda on which developing countries can forge their paths following their peculiarities, collecting the many existing practicing and supporting each other through mutual cooperation.

Therefore, circularity urges to focus on cities, the places where most of the people live and where the unexpected challenge (climate or pandemic) hit harder. However, there are many difficulties in applying circular economic principles to the urban context also in those countries where is it studied for several years. The most frequent criticism deals with the complexity of applying a theoretical economic system to a practical framework as the urban one, and the lack of examples emphasized the problem. Anyway, a general definition of CC exists: a city is circular when embeds the principles of the circular economy across all its flows, activities and production frameworks. The definition of a circular city is a declaration of political intents, it is not a clarification for policymakers on how to lunch or accelerate the transition towards urban circularity.

The report collected tools and circular practices to produce a list of 5 steps that may be helpful to undertake the path of urban circularity: - define an intervention area in terms of scale (local, urban, landscape) and urban flows that cross the city (for example water, waste, energy, mobility etc.), - select an implementation strategy (top-down or bottom-up), - choice a circular action (EMF’s system of ReSOLVE), - establish a final targets to achieve (SDG’s of the Agenda 2030), - consider the peculiarities of the context. These steps were fundamental to create a sort of database where collect case studios, labeling each example to ease the classification and support the transferability in different realities.

Analysing the case studios, it is possible to conclude that in the African continent circularity has a wide range of applications both because traditional sustainable practices are still carried out, and due to the high number of young workers and entrepreneurs with innovative ideas that find their acting space in a nonrigid framework. Indeed, in some cases, circularity replaces a bad working (often non-existent) national infrastructure with the possibility of installing a virtuous new framework of services, thanks to a nonspecific policy about innovative approaches. Now, the requirement is to increase the cooperation between similar realities, spread awareness and promote the sharing of the existing circular best practices.

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